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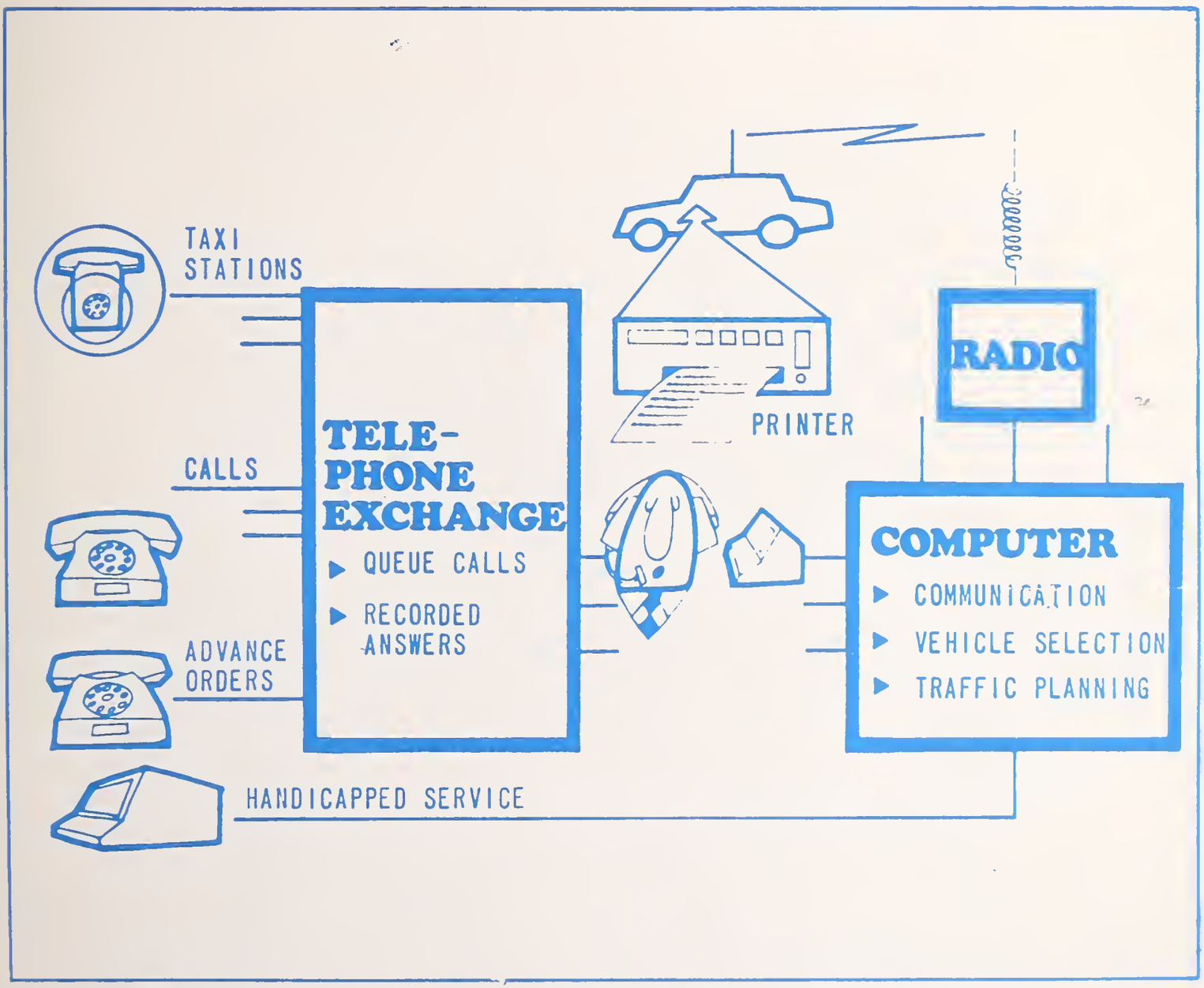
Taxi-Based Paratransit Technology/Operations Packages in Europe

May 1985



NOTE: This report is a review of taxi dispatching and fleet management approaches in Europe. Part of its content includes descriptions of these operations and recommendations for their implementation in the United States. Recognizing that there may be many alternative approaches to meeting urban transportation needs, these options may not necessarily be the appropriate ones for implementation. No endorsement of any specific approach described herein is either intended or implied by the U.S. Department of Transportation, or the U.S. Government. Names of manufacturers or hardware suppliers are included only because they are essential to the technical content of the report.

Taxi-Based Paratransit Technology/Operations Packages in Europe

Final Report
May 1985

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PREFACE

This report is one of six volumes prepared between 1981 and 1984 by EcoPlan under the sponsorship of UMTA's Office of Bus and Paratransit Technology. The work has been directed by Mr. Edward L. Neigut, Project Manager, of UMTA'S Paratransit Integration Program.

The report has been prepared in Paris by an EcoPlan project team consisting of Allen F. Damon, Ilse Obermayr and L. Milo Perichitch, who have been responsible for all field work and interviews, working under the direction of F.E.K. Britton, who has served as project manager and principal author.

Extensive support for this investigation has been extended by a number of people and institutions across Europe, North America and Australia. The names of the main contributors of ideas, information, and supporting materials will be found in the annex to this report. We are grateful for the help and guidance they have so generously extended to us over these many months, and hope that our independent view of their projects and their prospects will prove of some use to them in turn.

For all those who have worked to make TaxiCom successful in each of the places reported on here, we should like to express our appreciation. We sincerely believe that the technology and operations packages that they are in the process of achieving have potential application in many other places, and that their pioneering efforts deserve international recognition.

The fact that these projects are going ahead, that real transportation improvements are being made, and that all needed investments and preparations are being fully handled by private sector organizations without the need for either public subsidies or heavy government involvement, is a testimonial to the vigor of this new approach. And of its appropriateness for these times. If this report can make a modest contribution in this respect, we can only be pleased.

Francis E.K. Britton
EcoPlan - Paris
1 May 1985

EXECUTIVE SUMMARY

"TaxiCom" is a name developed by EcoPlan to blanket a certain range of innovative paratransit technology and operations packages for taxi companies which are coming on line in Europe with increasing frequency. These systems, which are also called "Third generation dispatching system", first began to receive research attention in Europe just about a decade ago.

By the end of 1984 this ten year long research push had developed to a point where a small but growing number of European suppliers are now competing on the market with a variety of proprietary systems which combine computers, microprocessor electronics and digital radio technologies to achieve new levels of sophistication and cost effectiveness in the dispatching and management of taxis. Today there are thirteen such systems of various types in or about to enter into commercial operation in Europe, with a fourteenth on line as the core dispatcher for a local courier/delivering service.

TaxiCom offers a range of services that on the surface look broadly similar to a traditional taxi system. Yet closer inspection reveals some highly innovative additions which not only increase the efficiency and speed of service both for conventional purposes and for a range of new services including for the transport disadvantaged, but also promise to redefine the role the taxi is to play in the broader global public transportation picture in the years ahead.

This report walks the reader through each step of this new technology. It opens with a general description of TaxiCom as a generic system and then goes on to exercise in some detail its major variants as they are being developed and actually working in the field today. It reviews the general philosophy behind the approach, its development history, and surveys the functions and achievements of the deployments in the field which have thus far been made in Europe. The report is based on extensive field research, on-site interviews and contacts with virtually all of the major points of expertise on this topic in Europe, as well as more partial coverage of what is going on in this respect in North America.

The technology behind TaxiCom, whatever its specific brand name or type, links a central dispatching service to all vehicles in the target system by means of computerization and digital communication. This process is made possible by the use of microprocessor-based equipment located in each taxi, and of a state-of-the-art host computer, strategically positioned relay stations, PABX telephone and radio dispatching system which is located at Central. Dispatchers and taxi drivers are thus relieved from the harried and ultimately inefficient atmosphere of voice radio communication, and each is allowed to concentrate directly on his job. This leaves the actual process of dispatching - that is matching a customer with a taxi - to the computer, which ensures that this union is made quickly and efficiently.

The following diagram illustrates the main principles of one type of TaxiCom operation.

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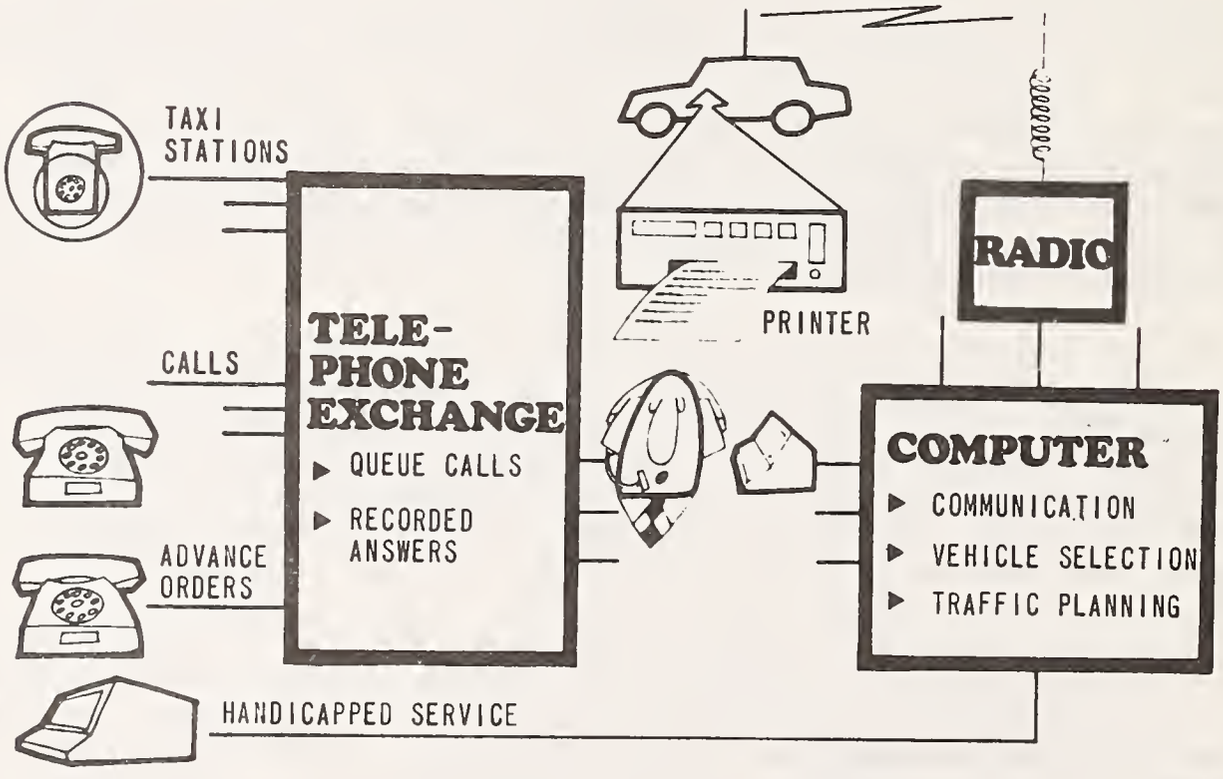
Figure 0-1: TAXICOM - GRAPHIC OVERVIEW



Source: VTS

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A typical TaxiCom order is processed in the following manner. A customer desiring a taxi telephones Central and is connected with an operator/dispatcher. After eliciting the essential ordering information, guided step by step by a series of messages which appear on the terminal of his/her work station, the operator/dispatcher keys this data into the host computer. The computer immediately poles available or soon to be available taxis and transmits this order to the closest. The driver of the selected taxi immediately responds through digital communication. Assuming he accepts the order, this information is transmitted back to the operator/dispatcher, who then informs the customer of his confirmed order as well as give an estimated time of arrival. This whole process can take place in as little as 15 seconds.

The benefits of this technology are not restricted to dispatching, where the efficiency gains have been shown to be considerable. The central computer can also be employed to calculate demand and both to plan fleet requirements and allocate taxis within the city accordingly. This further increases TaxiCom's ability to provide superior service, since the vehicles can be positioned closer to the areas where they will be most needed, while at the same time ensuring appropriately heavy usage of all those vehicles that have been slated for service within the period.

There are further a wide range of fleet management tasks that can be performed with heretofore unachievable levels of detail and efficiency as a result of applying the new computer resources to such tasks as planning, standing account management, route planning for package delivery and ridesharing, etc. Of course there are other ways of using computers in taxi management to achieve these objectives, but the beauty of TaxiCom is that it provides a means for linking virtually all aspects of management to daily operational procedures so that reporting can be greatly simplified and more accurate.

It is our finding that the benefits of computerized fleet management -- while somewhat downgraded in most of the projects reviewed here, as a result of concentration on dispatching improvements -- may just turn out to be the most important of the longer term advantages of such systems. To this end the report recommends that considering communities and companies give close attention to this part of the TaxiCom equation when they are deciding about and planning their new system.

A second message which we feel is worth stressing is that the places most likely to turn to TaxiCom (and to benefit most from it) are just those communities and taxi operations that have **already** taken some steps in this direction. Thus, TaxiCom gives them, as much as anything else, not a magic wand to transform their otherwise failing or moribund operations, but rather a structured program along which to channel yet further operational, technological and management improvements.

There are presently four, possibly five, separate sources of this technology in Europe. Each offers a consultancy and software package together with the equipment lines which they have worked with in the past (but most of which they do not themselves actually manufacture). Despite the fact that these various approaches have much in common, on paper at least, the fact is that they are at present at markedly different stages of development and the potential user will do well to ensure that he is dealing with a firm with a fully authenticated product and track record.

Of European Sources, the best known and in many ways most advanced version, Taxi-80, has been in commercial operation in Sweden since 1982. The system was developed initially by Volvo, who was later joined by LM Ericsson the Swedish radio and electronics firm, in an effort to solve a specific local transport problem. After four years of meticulous research and development work in the Volvo laboratories and on the streets of Gothenburg beginning in 1976, there have since 1982 been no less than eight operational deployments of this TaxiCom technology and operations package.

A broadly similar but rather simpler system, Telco, has been up and working in Zurich since 1980, with a new service (TTC) using an initially identical but now increasingly proprietary telecommunications/data processing technology soon to be deployed in the city of Rotterdam in the Netherlands.

Yet another systems package along these lines, Computer Cab, went into service in London in July 1984, while a Danish subsidiary of the Philips group has developed its own proprietary system under the name AP-Tax, which is generally being brought into service in Oslo and about to go on line (May 1985) in Stavanger, Norway.

While in North America there is a growing interest in the taxi business in such systems, actual deployments lag considerably behind what is being accomplished in Europe. The first such taxi application in North America was in Calgary, Canada, which entered into service in 1984. By contrast, North American applications of technically similar systems in other fields have raced ahead in such areas as police departments, public utilities, fire departments, and package delivery services, some of these on a very large scale. This technology and systems experience has real potential for taxi applications as well and deserves to be considered.

U.S. cities considering implementation will wish to know about and evaluate all of these approaches, but are at the same time urged not to ignore eventual North America sources of expertise and equipment, of which there are several which are identified in the Annex to this report.

The following figure provides a good view of the speed with which these new systems are coming on line in Europe.

Figure 0-2: NUMBER TAXICOM SITES/VEHICLES IN USE IN EUROPE

Year	Total Number of: Systems	Vehicles
1979	0	0
1980	1	400 **
1981	1	400 **
1982	3	1225 ******
1983	7	3401 **********
1984	10	5153 **********
1985	15	9863 **********

A good summary of the main European projects surveyed by EcoPlan to date, together with some essential cost information, is provided by the following:

Table 0-1: TAXICOM ATTRIBUTES - OVERVIEW
(In US $ at 20/10/84 Exchange Rates)

Project Site	System	Country	Year Init'd	No. Taxis	Total System Cost (US $)	Cost/Vehicle All	Cost/Vehicle On-Board Equip.
Gothenburg	Taxi-80	Sweden	1982	615	$1,506,373	$3,200	$2,000
Malmo	Taxi-80	Sweden	1982	210	$1,042,874	$4,966	$2,317
Stockholm	Taxi-80	Sweden	1983	1725	$7,762,500*	$4,500*	$2,317
Linkoping	Taxi-80	Sweden	1984	77	$451,912	$5,869	$2,649
Boras	Taxi-80	Sweden	1983	62	$289,687	$4,672	$2,430
Baerum	Taxi-80	Sweden	1984	225	$1,022,727	$4,545	$2,939
Trondheim	Taxi-80	Norway	1983	189	$600,000	$3,200	$2,400
Bergen	Taxi-80	Norway	1985	310	$1,254,545	$4,047	$1,870
Oslo	AP Tax	Norway	1985	1375	$4,318,182	$3,140	$2,066
Stavenger	AP Tax	Norway	1985	145	$1,022,727	$7,053	$2,614
Zurich	Telco	Switz.	1980	400	$1,209,677	$3,024	$2,117
Rotterdam	TTC	Neth.s	1985	580	$1,231,672	$2,124	$1,567
London	Comp.Cab	U.K.	1983	1630	$1,809,406	$4,195	$2,151
Average				580	$1,798,218	$4,076	$2,145

* Stockholm total system cost cited by VTS at SKr. 25 million - We have substituted above figure after our analysis of detailed project data.

TaxiCom conversion costs depend, first, on the level of sophistication that is targeted at the outset; and, then, on the extent to which adequate equipment (e.g., computers, PABX, appropriate radios, relay stations, etc.) is already in hand in the sponsoring organization. A review of the thirteen deployments implemented and planned to date shows that total systems budget on the order of $2 - $5000 per vehicle will be appropriate, depending on the complexity of the system being sought, with about half of the project budget accounted for by expenditures for equipment within the vehicles themselves.

A survey of these deployments shows that even in the instance of the more expensive conversions taxi owners appear to be able to cover their mobile equipment costs within a year or two, while the costs of conversion of the dispatching centers and associated equipment appear to take about twice as long to pay back. In some places, driver/owners report that they have been able to pay for their equipment in as little as six months.

With several years of experience now in hand in a variety of sites of different sizes and complexity, it can be safely surmised that TaxiCom offers an attractive, implementable transportation alternative with seemingly few drawbacks. For this reason, unlike many of the more recent examples of paratransit systems, TaxiCom has not had to be rammed down the throats of a recalcitrant public. The system, if carefully planned and properly implemented, offers different but numerous and quite tangible benefits to virtually all those involved. These have been seen to include:

- To the travelling public, it offers a way to improve and extend the services of a transport mode which is available in a large number of communities where no other public transport means exists, and is often used by the transport disadvantaged as a form of "transport of last resort".

- To the individual passenger, advantages of convenience, more efficient ordering, more reliable service, a quieter ride, improved safety, and, eventually, lower taxi prices and more service.

- To the driver, it holds out the possibility of more convenient operation, better customer relations, improved working conditions, increased security, and better earnings.

- To fleet owners, it offers a way to cut operating costs, make better use of both vehicles and manpower, increase revenues, and eventually to increase profits.

- To public transit operators, it can provide a way for substituting for high cost line services in off-peak periods and/or outlying areas, and thus reduced deficits.

- To funding government agencies, it offers a way to substitute unsubsidized private transport for costly deficitory public services in certain low density situations, and thus both to extend service coverage and to cut back on deficit financing.

Among the most enticing aspects of TaxiCom is the potential for yet further innovation and improvement which it sets up, by dint of the fact that it provides a way to "loop" daily operational results back into the management information system of the taxi company in a way which is at once easy to do, low in cost and highly effective. Because of this structure, the system and service can continuously be refined and improved on a continuing basis without needing major new investments and disruption, and which can be effected with little adjustment to the existing technology.

==========

GLOSSARY

AP-Tax	Proprietary name of system developed by AP Radio in Denmark.
AVL/AVM	Automatic Vehicle Location or Monitoring Systems.
Central	Taxi Dispatching and Control Center.
Deadheading	Any vehicle movement when the taximeter is not turned on.
DRT	Demand-Responsive Transportation system.
E.T.A.	Estimated time of arrival.
E&H Transport	Special transport arrangements for the elderly and handicapped.
Fardtjanst	Special transport service for elderly and handicapped. Uses both own vehicles and taxis. Initiated in Gothenburg in 1968. Now in all Swedish cities.
O/D	Origin/Destination service.
PTIP	The Paratransit Integration Program of the Urban Mass Transportation Administration.
PubliCar	A shared vehicle or "club car" where ownership and/or use is collective in nature, permitting multi-family or inter-group use of a car.
Taxi-80	Name use by Volvo to describe their computerized taxi service.
TaxiCom	EcoPlan appellation for this new taxi service/technology package. (Taxi + computer, communications, commuter.)
Telco	Telefon-Computer; proprietary name of system initiated in Zurich.
Telebuss	Volvo's pioneering mid-seventies DRT project which was a direct technological antecedent to TaxiCom.
UMTA	Urban Mass Transit Administration of the United States Department of Transportation.

Rates of Exchange per $1.00 U.S. (20 October 1984).

D.Gld:	Dutch Guilder	3.41
£:	English Pound Sterling	0.82
N Kr.:	Norwegian Kronar	8.80
S Kr.:	Swedish Kronar	8.63
SF :	Swiss Franc	2.48

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TAXICOM:

TAXI-BASED PARATRANSIT TECHNOLOGY/OPERATIONS PACKAGES IN EUROPE

> The summits of the various kinds of business are, like the tops of mountains, much more alike than the parts below. The bare principles are much the same; it is only the rich variegated details of the lower strata that so contrasts with one another. But it needs travelling to know that the summits are the same. Those who live on one mountain believe that their mountain is wholly unlike all others.
>
> Walter Bagehot, The English Constitution

1. INTRODUCTION

This report surveys a rapidly emerging range of technologies and operational refinements which are currently being developed and used in Europe to achieve major improvements to and extensions of taxicab services. These systems are already achieving some interesting results in the first dozen commercial installations thus far put into service there and clearly hold out considerable promise for near term use in the United States.

1.1. Background

EcoPlan was commissioned by the Urban Mass Transportation Administration (UMTA) of the United States' Department of Transportation to select and provide background documentation on those paratransit technologies and projects currently being developed in Europe which are particularly ingenious in their approach, original in their nature, far-reaching in terms of their potential impacts, and which look as if they might prove useful as sources of ideas and inspiration for communities looking for new and more cost-effective transport services.

The original mandate called for focus on systems of potential for near-term application in U.S. cities and communities. The fact is, however, that most of what is reported on here turns out to be relevant to transport planners and service providers around the world.

The present volume does not cover the entire range of technologies and projects which EcoPlan was instructed to survey at the outset of the project. Rather it focuses on the technology area which we found, upon study, to be most promising for near term implementation in the United States. This proved to be a range of projects which we eventually grouped and studied under the common name of **TaxiCom**: a variety of operations and technology packages which make use of digital radio, microelectronics and computers to permit taxi companies both to operate more efficiently in their established conventional modes, as well as to offer entirely new types of services both for the general public and the transport disadvantaged.

While still experimental in terms of certain of their more refined and ambitious details, the longest standing of these projects has now been in full commercial operation for four years now and has proven itself in daily operations over the full period. No less than a dozen broadly similar projects have been planned or put on line since, virtually all without the benefit of public subsidy and entirely within the private sector. This new technology and operations approach has managed to establish an impressive track record in a variety of urban settings. Moreover, it offers an approach which clearly lends itself to a broad range of operating environments, including to many communities in the United States.

1.2. Scope and Objectives

The research project on which this report is based was commissioned by the Urban Mass Transit Administration (UMTA) of the United States' Department of Transportation and was carried out by EcoPlan over the period between 1981 and 1984. The mandate was to provide UMTA with background documentation on a certain number of leading technology-based paratransit projects currently being advanced in Europe. In particular EcoPlan was instructed to look for technologies and service approaches which might prove useful for local transport both: (a) for the transport disadvantaged; and (b) in hard-to-serve lower density areas in the United States.

The geographic scope for this project is West Europe other than the Federal Republic of Germany, which is being covered by another consultant to UMTA. Since there has in fact been a fair share of related project activity in the Federal Republic as well, we recommend that the interested reader also endeavor to obtain full information on these developments as well as what follows.

1.2.1. Program Objectives: In-House Working Studies

UMTA set two sets of objectives for this project:

First, EcoPlan was instructed to prepare specifically for the Office of Bus and Paratransit Technology a set of working papers, each of which was intended to provide a general introduction to and supporting materials on five pre-selected European paratransit technology development projects or areas. To this end a cycle of internal working documents were submitted by EcoPlan over the period 1981-1983. These covered the following technology areas and projects:

* Working Paper # 1. TaxiCom - An expanding number of technology/operations packages which combine AVL and DRT routing to permit taxis to expand their public transit role, including for E&H transport. (The present report draws directly on the original EcoPlan submittal under this title.)

* Working Paper # 2. La Stus - A pioneering multi-level public public/paratransit service in operation in a small community in France since 1977. The central technology element of this project is a series of "call boxes" which permit riders to summon transport vehicles off of the main line to lesser used stops (check points).

* Working Paper # 3. BusTaxi - A demonstration project which combines Dutch planning and German DRT technology in a rural paratransit service that opened in the Netherlands in May 1983.

* Working Paper # 4. PGE PubliCar - A "shared car" demonstration project using electric vehicles and supporting hardware and software in limited pilot operation in Belgium since 1979. Placed in the context of earlier work along these lines in Britain, France, and the Netherlands.

* Working Paper # 5. Paratransit: Overview of European Developments - A general summary of and commentary on (1) European paratransit developments in general over the last decade, and (2) a sketch outline for a new hybrid paratransit project which combines some of the more successful technology elements and operational principles observed over the course of this survey. This proposed new service is called CHARM - Computer Helped Area-wide Rural Mobility system - and offers one way to harness the newly emerging tools available for dealing with the especially challenging transport problems of Europe and America's rural communities.

1.2.1.1. Panel Opinion on Potential of Surveyed Technologies

Each of the five commissioned working papers were completed and submitted to UMTA for its own in-house uses, as well as to an external review panel. In each case the reviewers were asked not only to give us the benefit of their suggestions and eventual corrections and additions concerning the report itself, but also to provide an evaluation of the potential of the surveyed technology for near term application elsewhere, including in the United States.

The strong consensus of review panels was that of the projects and technology approaches surveyed, the **TaxiCom** technology appeared to have far the greatest near term application potential in the United States. Accordingly, it was suggested that the final report for UMTA at this time should concentrate on these systems.

In the case of the **La Stus** project, the majority opinion was that what was of interest there was, primarily, the planning and organizational aspects of the project, to which the technology components took a back seat. That said, the reviewers also indicated that the so called "Call Box" technology at the core of La Stus check point service may be worthy of closer attention, if and when its development extends beyond the present very simple configuration. Therefore, continued monitoring of this technology by UMTA is recommended, with a view to an eventual public report on this topic when appropriate.

As to the **BusTaxi** project, the technology was evaluated as being definitely interesting to follow, but that more operational experience had to be accumulated before a major report should be prepared and distributed on this subject. Once again, it was suggested that UMTA continue to follow the progress of the project, with view to providing in due course and when appropriate more extensive public coverage of the technology.

By contrast, the **PGE PubliCar** project in Brussels was judged to be as yet too small, experimental and tentative in its results to be an appropriate candidate for a major UMTA publication at this time. The project should, however, be monitored for eventual progress.

Finally, the panel suggested that UMTA might find it useful to consider a bi-annual overview report on "Paratransit Developments in Europe", along the lines of the short volume submitted in draft form as one element of the current project.

1.2.2. Report Objectives and Timing

The goal of this final report is to provide a survey which can serve both as a readable introduction for non-expert readers on the lookout for new service ideas; and as a fairly detailed synopsis of the main technical, operational, and planning characteristics of both the technology and the specific service approach in question. The latter materials are specifically intended to aid the reader who may wish to move beyond a simple introductory description and to have in hand enough detail and references in order to determine:

(a) if this system or approach might in fact be of actual interest to his community or organization, and

(b) where to turn next in order to move this idea closer to actual realization, and for advance planning and implementation purposes.

This report has been prepared by an EcoPlan team working in close cooperation with local agency and national government sponsors, as well as with the concerned operators and technology sources. It has been the object of extensive field visits and interviews, as well as careful study of all available documentation. A complete listing of all sources of information consulted for this project will be found in the closing annex below.

The timing of the present report is extremely favorable both from the vantage of technologies themselves and from that of the market.

Until 1984 TaxiCom was still very much of an experimental system in Europe, with less than a handful of projects in actual commercial service, almost all of which too recent to have established a meaningful track record. By early 1985, however, this situation had evolved radically and today there are more than a dozen systems and 10,000 vehicles in full commercial service or about to come on line in Europe alone. As a result, it is now possible to begin to be definitive about what such systems have done and what they can be made to do in the future in communities elsewhere.

At the same time there has recently appeared a rising crescendo of interest in such systems in the United States. While no such systems have yet entered into commercial service in the US itself, three similar projects are either up or about to go on line in Canada, with no less than a dozen communities and fleet operators looking seriously into such technologies for near term application in the States, where contracts have already been signed for commercial projects in Indianapolis, Indiana, Anaheim, California and New York Citys.

Prior to 1984 the closest related technology development on the US scene had been an interest in systems with many common technological and organizational elements but used primarily in police, bus company and express delivery applications. These basically similar projects have advanced considerably over the past half dozen years in the States, and have laid an important groundwork for taxi applications, which are now about to begin in 1985.

1.3. UMTA Paratransit and Bus Technology Program *

The Paratransit Integration Program (PTIP) in the Urban Mass Transportation Administration's (UMTA) Office of Bus and Paratransit Technology, addresses a variety of issues related to computer and communications research and development for the planning, operation, and management of paratransit services. The program is designed to help local government, transport system operators, and shared-ride paratransit service providers to reduce costs, improve quality of service, meet the demands of elderly and handicapped citizens, and increase the mobility options of the general public.

The program focuses on:

- Planning and analysis tools and techniques;

- Computer-assisted and fully automated dispatching and scheduling systems;

- Paratransit coordination and integration among social service agencies.

1.3.1. PTIP Program Objectives

The objective of PTIP is to help make sensible use of computers and communications technology to improve service and reduce costs of paratransit operations. The program supports this objective through the research, development, and implementation assistance of transferable computer software packages for use in low-cost computer hardware. These systems are of a sort that can be used by local, state, and regional governments, as well as private paratransit service operators to plan, manage, and operate paratransit services.

The major benefits of developing and applying computer technology to paratransit services are seen by them as including:

- Improved levels of service and reduced capital and operating costs through better planning tools;

- Provision of efficient and economical special paratransit services for elderly and handicapped people, social service clientele, and the general public;

- Conservation of gasoline by reducing the use of private automobiles through increased mobility options;

- Better use of available vehicles and possible reduction in the number of used through centralized coordination and brokerage and better routing and scheduling.

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* Source: "Paratransit Integration Program", UMTA Technology Sharing Fact Sheet, Washington, D.C., September 1981.

1.3.2. History and Status of UMTA Paratransit Involvement

UMTA was one of the earliest and most vigorous sponsors of paratransit system development in the United States, and has been involved in a comprehensive research and development program in integrated paratransit since 1976. The program was originally initiated as the Areawide Demand Responsive Transit Program (AWDRT). In 1977 the title was changed to the Paratransit Integration Program. AWDRT and early PTIP activities covered a wide range of studies to assess the state-of-the-art in paratransit services, and identify research and development needs.

Currently the program is directed toward the development of planning and management tools and low-cost, less-complicated, computer-scheduling aids to assist in manual operation of paratransit systems. In addition, research and development for low-cost resolutions to fully automated routing and scheduling problems is continuing. Assessment and analysis of new and existing systems are being conducted, and substantial attention is being given to the automation needs for efficient coordination of paratransit services for social service agencies.

Paratransit is evolving as an important element of transportation. This program will continue to develop and deploy cost beneficial computer programs, tools, and techniques to satisfy paratransit service needs and to facilitate paratransit integration with conventional fixed-route transit. In 1983, the major emphasis of the program is shifting to deployment of computer systems at specific sites.

The present project represents the PTIP's latest international initiative, and has been initiated in the belief that U.S. decision makers and operators should be kept fully up to date on the leading project experience and technology developments, including those that are going on outside of the United States.

1.4. EcoPlan Project Background

This project builds on an EcoPlan "Transportation Technology Watching Brief" which dates back to 1969, the basic objective of which has been to monitor new technology developments in the transportation sector broadly defined, with particular attention to urban transportation. More than forty major reports have been prepared under this program since the first three volume report appeared under that title in 1970. All surveys in this series have been world wide in their technology coverage, other than certain proprietary studies which required a given geographic focus.

The present project traces immediately to two related but separate currents of activity in EcoPlan's Transport Research Group work program. One involves our long standing, continuing world survey aimed at mapping and understanding new paratransit developments. Within this particular program, a dozen major reports have thus far been published beginning in the mid-seventies and continuing through the present.

The second research current that lead directly into this project was the group's long term interest in the area of automatic vehicle location (AVL) and monitoring (AVM) systems, which has lead to a continuing scrutiny of new technology and project developments in both Europe and North America. Three major reports have been prepared in this series between 1977 and 1982, and show a number of interesting antecedents and links with what later became the TaxiCom movement.

In both these program areas EcoPlan has over the last decade carried out a number of assignments for UMTA. Members of the group have also participated in numerous conferences and workshops in order to brief UMTA officials and other U.S. agencies and groups concerning these developments in Europe and elsewhere outside of North America, with a view to seeing if any interesting leads can be found for eventual adaptation and application in the United States.

1.5. Presentation of the Report

This report is presented in six main chapters and one supporting annex, and is introduced by a brief Executive Summary.

Chapter I, "Background and Introduction", runs briefly through the origins of TaxiCom, reviews the origins and background of the paratransit technology program at UMTA that led up to this report, introduces the objectives of the study program on which this report is based, and rapidly sketches the structure of the full report.

Chapter II, "Background to TaxiCom's Emergence and Development", opens with a general introduction to the class of systems and technologies under study here, reviews the pace of developments in this area over the past decade, and then goes on to a consideration of reasons why these systems appear to make sense in practical operational situations, as well as to consider generally what some of their eventual shortcomings might be.

Chapter III, "How TaxiCom Works", provides a broad overview of how these systems operates in general; first from the perspective of the user, then from that of the driver, and finally from an overall system's viewpoint. This is presented both as a general introduction to TaxiCom and as a baseline description from which the various specific technology packages and site deployments can later be compared and contrasted.

Chapter IV, "The European Technology Sources", looks at the main technology sources currently offering TaxiCom systems in Europe as of this date. Each is identified in terms of the origins of and motives behind the original development project, its current deployment status in terms of actual on-street operations, and finally with reference to the main differentiating factors that set it apart from the competition.

Chapter V, "The Results", describes and analyzes the main results achieved to date by these various TaxiCom installations, not on a case by case basis but trying to view them, their accomplishments and their eventual drawbacks as a whole. This is followed by an examination of the main costs incurred at each of the sites to get these projects up and running, so that the reader can get a grip on the levels of investment that may be likely in his particular case. The chapter closes with a general consideration of project finance and payback periods, noting the generally favorable situation that the results to date seem to imply.

Chapter VI, "Planning and Implementation", reviews some of the main considerations that need to be dealt with if a TaxiCom service is to be developed and brought on-line in a given community. This chapter attempts to help guide those who have decided possibly to implement such a system, outlining the principle steps that must be taken in order to get the best possible project along these lines fully up and running.

Annex A, "Key Contacts", provides a detailed and fully up to date listing of the main known sources of information and expertise on these systems, in both Europe and West Europe. This information is given in highly detailed form (full address, telephone number, telex, where available), in order to provide concrete leads for those needing to deepen their knowledge of TaxiCom through further contacts.

2. BACKGROUND TO TAXICOM'S EMERGENCE AND DEVELOPMENT

TaxiCom has been selected as the first paratransit technology class to be reported on publicly in this series because: (a) it reports on three fast moving and highly promising technology vectors: digital radio, microprocessor electronics, and computers; (b) it is clearly working quite effectively in Europe, (c) it offers an approach which appears to have genuine application potential in the United States, and (d) there is evidence of a growing wave of interest in this approach beginning to form up in the United States.

Because there are a large number of communities who may wish to look into the appropriateness of this general kind of system in the near future, UMTA has prepared this report for background purposes at a time when little is available to help guide them in this respect.

2.1. Why TaxiCom?

This report focuses on a range of technology and operations packages that is fast taking hold in Europe and which has been in full scale commercial operation there since 1980. TaxiCom systems, whatever their specific technology or source, have in common that they attempt to make effective use of available computer and telecommunications technologies to improve the commercial effectiveness and to expand the role of taxicabs in both urban and lower density settings.

Despite its relatively short operational track record, TaxiCom has a development history that traces back a full decade. Its roots lie firmly in the mainstream of the paratransit movement: both as things have evolved in the United States and in Europe, as well as in the on-going (and in most places quite separate) flow of improvements which are being sought and put into place by the taxi trade.

TaxiCom has been selected for study in this series for several reasons:

* It demonstrates a set of operational approaches, equipment, and planning procedures that could, with only minimal "tailoring", and at what would appear to promise to be an acceptable level of costs to those most directly involved, be put to work effectively in appropriate U.S. contexts.

* It appears to offer one of the rare examples of a paratransit innovation that can be entirely self-financing, and thus is not dependent on public subsidies.

* It offers a way for extending private taxi operations -- which already account for fully 10% - 20% of all public transport patronage in most European cities, including a large share of elderly and handicapped patrons -- to provide a much fuller range of public services, at least some of which would appear to be otherwise unobtainable by more conventional transit approaches.

* It holds out a way for turning around marginally profitable and even loss-making taxi operations which in many places are in danger of going out of business altogether unless new sources of revenue and productivity increases are uncovered.

* It covers, in addition to the particular variant selected for the purposes of this project, a fairly broad range of service and technology options, many of which will be worth at least screening by those U.S. communities which are on the lookout for new service approaches.

* It provides an opportunity to update the U.S. reader on state-of-the-arts taxi paratransit developments in not just one but several of the European nations where paratransit has been receiving most attention over the past decade, and where things have proceeded in way which are quite different from U.S. experience.

2.2. Information and Control Systems for Taxi Use

In Europe, as in the United States, computer-based information and control systems of a wide variety of types and qualities have been put to use by a taxi industry over the past two decades.

Thus far the most common use has been for accounting, payroll and limited management information use. In most countries, the larger taxi operations have long recognized that the cost of automating these clerical functions are readily justified by the benefits. In point of fact, however, the pace of these developments has been highly uneven, with the type of approach, equipment, sophistication and practical results varying hugely from country to country and (even more) from operator to operator.

At the leading edge of the taxi industry there has been some interest in more advanced uses of computer-based systems (i.e., other than the above); but within Europe, most of this activity has been channeled along the lines of projects which we lable here as TaxiCom.

One area in which there has been some spill-over to the taxi industry has been with Automotive Vehicle Motoring and Location (AVM and AVL) systems used for buses and public transit, though the only country in which this direct linkage has been strong and clear has been in West Germany. There, the development work of Messerschmitt-Boklow-Blohm, Siemens Haeni, the Federal Ministry of Research and Technology, the Studiengesellschaft Nahverkehr, and the Public Transit Authorities of the cities of Hamburg, Hannover, Munich and Friedrichshafen have helped edge along radio and computer-based information and control systems and transit, to the point where there begin to be some obviously interesting overlaps for taxi operations and use. Other than in the Federal Republic, however, these two currents of technology development have preceded along fairly separate lines.

2.3. Pace of TaxiCom Development and Penetration: 1979 - 1985

What this report labels as TaxiCom are a collection of systems which represent the latest of a series of stages of upgrading of taxi dispatching systems. Since this is part of a continuing process which has already been going on for some time now, we might wish to think of them as **third generation** dispatching systems.

The previous generations can be characterized as including:

* Generation 1 - Equipping taxi stands with telephones for direct client orders

* Generation 2 - Radios in taxis for voice radio dispatching from Central

And while there has been continuous improvement in the technology and efficiency of these second generation systems since they were first introduced several decades ago, it became clear as the seventies wore on that these had to be better ways to deal with the problem.

These third generation systems are now beginning to come on line in Europe with increasing frequency. With their first origins in the pure research stage in the mid-seventies, as late as 1980 they could still legitimately be thought of as an experimental technology. Today, however, with new projects coming into full commercial service every few months and growing number of firms lining up to vie for this rapidly expanding market, this is clearly no longer the case.

As of this date full-scale TaxiCom operations are at work in a dozen European cities, wherein private sector firms are transporting several hundred thousand people every day. More are already in the planning stages in Norway, Denmark, Sweden, France, the U.K., the Netherlands, Japan, Canada, Australia, and Singapore, to name but those known directly to us. At the same time, there are indications that a growing number of US communities are beginning to be aware of the potential for innovation along these lines and are beginning to strike out to achieve new systems along the lines themselves.

At present there are four main lines of technology and systems approaches which account for all hands-on activity in the sector here in Europe, with a fifth about to come on line in 1985.

- Taxi-80, the best known and in many ways most advanced of the four has been developed jointly by Volvo Transportation Systems (VTS) and L.M. Ericsson in an effort to solve a specific local transport problem. It has been in commercial operation in Sweden since 1982, and currently has eight projects in operation.

- AP-Tax, the system developed between 1980 and 1984 by AP Radio, Danish subsidiary of the Philips group. They have developed their own proprietary system and are currently in the process of bringing it on line in Oslo and Stavanger, Norway.

- Computer Cab of London has created its own systems package along these same general lines, which has been in service in London in a simplified first stage version since the middle of 1984.

- Telco, a Swiss firm, initiated work on its system in 1976. It has been up and working in Zurich since 1980.

- TTC Taxi, Netherlands, a new service using a similar (to Telco) but proprietary telecommunications/data processing technology, opened in April 1985 in the city of Rotterdam in the Netherlands.

These five systems differ in many ways in terms of the detail of their techniques, ambitiousness, and costs. As important, they differ considerably, as will be seen, in terms of their degree of readiness for the market. Despite these differences, all follow a broadly similar pattern, which permits us to present and comment on them as a whole.

On the face of it, these contending suppliers are an odd lot. Volvo is above all a motor vehicle manufacturer, while Telco and Computer Cab are both basically good sized of taxi companies and dispatching services with no manufacturing or electronics capacities. Only Philips, a manufacturer of a wide range of electronics and telecommunications hardware, appears on the face of things to be logically positioned as a prime technology source for this type of system; but even there it is not the mother company that is running with the ball (yet!?!) but a small independent Danish subsidiary.

Each of these groups has labored over several years to develop and prove on site its own proprietary hardware, software and operations packages. As will be seen, the present state of their development is anything but even.

Given the nature of these projects, each group takes as its main function to serve in tandem both as a specialized transport consultant for system design and implementation, and as a "general contractor and purchasing agent" who works directly with the city and/or cab company commissioning a given project to help adopt their (the supplier's) proprietary TaxiCom technology and approach to the unique environmental and operational requirements of the target site. None of the five manufactures more than a portion of the hardware required to make the system work. Instead they turn to outside suppliers for much and in some cases (especially Computer Cab, Telco and TTC) virtually all of this.

2.4. A Word on Nomenclature

This report introduces a new general term for the kinds of systems and approaches under study here -- "TaxiCom". Our reasons for imposing this perhaps awkward word on the reader are several.

First, because a number of different names have been used for this sort of approach over the half dozen years or so of its development cycle. Among these we would note most notably: "Taxi-80", "Telco", "Computer Cab", "AP-Tax"... and yet others depending on time, place, and who is talking. Each of these names represents a specific technology package or site -- and one of the objectives of this study is to show not only what they can do, but how they differ. That said, despite the differences, they have much in common and it is possible to discuss them under a global tag such as TaxiCom.

Second, because within each project a number of different groups and suppliers have been working to forward its development. Thus, it is not really possible to fairly label it the "Volvo system", the "Ericsson system", the "Telco system", the "AP-Tax system", or by any other single supplier label. Similarly, it is inconvenient and cumbersome to keep spelling out such eventual generic names as "Automatic Taxi Communications System" or, even worse, "Automatic Group Taxi Dispatching System", "Taxiledningssystem", or "Computergesteuertes Taxi-Dispositionssystem"... despite the fact that all are used in different places and have thus full claim to legitimacy.

Third, we rather like this sobriquet because of the useful ambiguity offered by that "Com" tag. This can be variously read as an abbreviation for computer, for communications or even for commuter... all of which are meaningful in the present case.

Fourth, our use of an altogether new name allows us to bridge over some of the fundamental, and not trivial, differences that can be spotted between: (a) the systems such they exist today (i.e., in a still limited form and early evolutionary state); (b) and the more extensive and powerful kind of services that we believe are going to bloom now that the first full-scale commercial systems are up and running on a profitable basis.

Finally, we have chosen to introduce this new word because we firmly believe that what is critical in this instance is not the specific technology package that we have addressed ourselves to here, or even the broader operations package encompassing it, but rather the whole and invigorating approach that it shows to technical innovation and performance improvement in a complex social system. Since this last is what lies at the bottom line of our interest, it seemed appropriate to "de-link" some of the more narrow proprietary considerations, with our choice of this neutral name being one step in that direction. For this, "TaxiCom" would seem to be a good choice.

2.5. Advantages and Eventual Drawbacks

In contrast to some of the more sophisticated paratransit projects which we have watched fall on their face in the United States over the last decade, TaxiCom is most clearly **not** an example of an isolated technology development effort. The system is heavily needs-oriented and has taken a number of years to bring to maturity, with close and continuing collaboration between industry and operators in a number of settings.

It is interesting to note in this respect that there has been virtually no involvement by national governments in this technology at any stage of its evolution at any of its sites. This hands-off attitude of the Swedish, Swiss, Danish, British and Dutch governments have applied not only to the TaxiCom development projects which are set out in these pages but also to virtually all technology projects in the public transport sector. Similarly, the initiatives in all remaining countries where such systems are presently on line have been entirely in the hands of the private sector and the communities directly involved.

The end result is a system which on the surface may look relatively simple and which in fact does not involve any hyper-sophisticated technologies. What it does manage, however, is to blend useful technology innovations, felt needs, and operational requirements and capacities in a way which permits notable improvements in the local transport situation from a number of perspectives.

One of the unusual characteristics of the TaxiCom approach is that it appears to hold out something of interest to just about every group or institution which would be eventually involved in bringing such a project about. What a contrast with many of the more exotic transportation technology proposals of the recent past! Certainly, there can be little doubt that one of the main reasons that this approach is currently enjoying a development boom is that it offers practical benefits for all of those concerned, across the board.

2.5.1. Targeted Inprovements

TaxiCom systems are being implemented in Europe today because they address felt needs in what a growing number of businesses appear to believe are practical, cost-effective ways. Of course, there can be no guarantees in advance that any given implementation is going to be able to achieve all its objectives. Nonetheless it is possible to list quickly most of the main targets which most of these projects are aiming for:

1) Increased dispatcher productivity:

- Permit major expansions in productivity without increasing labor costs at dispatching center.

- Better ability to schedule dispatchers/operators to deal with daily or hourly variations in demand.

2) Faster handling of incoming calls:

- Busy signals virtually eliminated;
- Order time decreased.

3) Automatic computer selection of vehicle:

- Improves speed of assignments;
- Identifies most appropriate vehicle;
- Eliminates "scooping" of orders by drivers;
- No fraud or bribing of dispatcher;
- Reduces dispatching errors:
    - Computer checks address for accuracy;
    - Driver gets order in "writing".

4) Less time required for caller to be informed of:

- Service availability (or absence thereof);
- Time of pickup.

5) Prompt arrival times:

- Computer can figure O/D times better than human dispatcher or driver.

6) Digital Radio:

- Improves radio channel efficiency permitting more vehicles/channel;
- Increases speed of transmittal;
- Reduces errors;
- Eliminates noise in vehicle and dispatching room.

7) Improved working conditions for:

- Drivers;
- Telephone operators/dispatchers.

8) Improved safety and security for:

- Driver;
- Passenger.

9) Conservation of fuel through:

- Better fleet deployment, (i.e., positioning);
- Less deadheading.

10) Profitability increases within system of up to 30% resulting from:

- Decrease in costs;
- Increase in revenues.

11) Generally, all around better taxi service which is:

- Faster;
- More efficient;
- Maybe even less expensive: (i) if some savings are passed on, and (ii) with, eventually, phased introduction of shared rides.

12) The longer the system has been functioning, the better it will work;

- i.e., self-generating expertise based on continuous collection of data and feedback into dispatching and management information systems.

As will be seen, no two of the TaxiCom projects brought into service to date are identical in all these respects. They differ considerably in terms of size, budget, technological sophistication and in many other respects, including their performance. Nonetheless, virtually all are aiming at virtually all of the above targeted benefits.

2.5.2. Potential Problems and Shortcomings

In spite of the many benefits that a well planned TaxiCom can bring, there are also a handful of possible negative impacts which deserve to be considered before deciding to commit time and money to this new technology. As the man said, "There ain't no such thing as an absolutely free lunch".

2.5.2.1. Less On-Street Taxi Availability

Since TaxiCom keys on the use of a telephone for ordering, the system will not provide the same level of service to those who wish to access a taxi by one of the more "traditional" methods. TaxiCom does not, for example, aim to provide service for those who wish to hail a taxi from the street or to go to the nearest taxi stand. With TaxiCom, vehicles will rarely cruise the streets empty or wait passively by a taxi stand. (However, this latter problem could be solved by installing a direct line to Central at the taxi stand, or by the use of appropriately placed public telephones.)

This is not to say that communities which bring TaxiCom projects on line are no longer going to offer their residents the possibility of picking up a taxi in the street, but merely that since most of the vehicles within the system will be geared to providing radio-telephone pick-up, there will simply not be as many available on the street.

That said, the fact that a well-working TaxiCom is going to be able to improve the spread of empty taxis over the service area, is likely to improve the hailer's chance of finding an available cab on the street.

2.5.2.2. Bias Against Those Without Telephone

More gravely, TaxiCom is biased against users who do not have a telephone or access to one at the time they wish to place an order.

Though there is no real remedy to this quandary, it is worth noting that in most of those countries where TaxiCom is now penetrating -- as indeed is the case throughout most of the United States -- telephone ownership is sufficiently high as to render this as nothing more than a marginal drawback, which itself could be dealt with in other ways if necessary.

2.5.2.3. Intrusion on Driver Independence

Some drivers will have an initial aversion to the computerized aspect of this new dispatching method and the more or less continuous radio contact with central.

In response to this, it should be noted that if a particular driver prefers not to employ TaxiCom, he always has the double option: first, of not buying into the system; or, second, of turning it off and continuing to drive for a period of time without it. It seems, however, that the demonstrated potential for increased earnings should cure any apprehension drivers may feel about this technology.

2.5.2.4. Investment Requirements for Taxi Owners

The initial investment requirement of TaxiCom is, as will be seen, not inconsiderable, and this can often be enough to frighten off interested parties. Yet one must not let one's first view of the system's costs alter an otherwise positive reaction to TaxiCom.

Experience to date suggests that the system has the ability to pay for itself, and indeed this has been the case in virtually all of the cities in which TaxiCom is presently operating. Furthermore, in all cases financing has ultimately been found, both for the systems overall costs and for the mobile units each driver must personally invest in.

3. HOW A TAXICOM SYSTEM WORKS

The following chapter describes how a typical TaxiCom installation works in actual practice. This is shown first from the perspective of the passenger, then from that of the driver, and finally from that of the dispatching center and its various supporting parts. The details of the various technology and operations packages currently on the market and of the results obtained in actual deployments of such systems to date are treated elsewhere in this report.

3.1. Overview

TaxiCom systems, whatever their origin and technology content, have in common that they are all designed to help people get taxis more quickly and easily; to help taxi drivers get quickly to their customers, cut down on their costs, and increase their earnings; and to help dispatchers improve their efficiency and the number of vehicles they can handle. As such, and because all rely on such common elements as computer-aided dispatching and digital radio communications, they have many common attributes.

A global pictorial overview of how one broadly representative TaxiCom system works (in this case, the Telco system in Zurich) follows.

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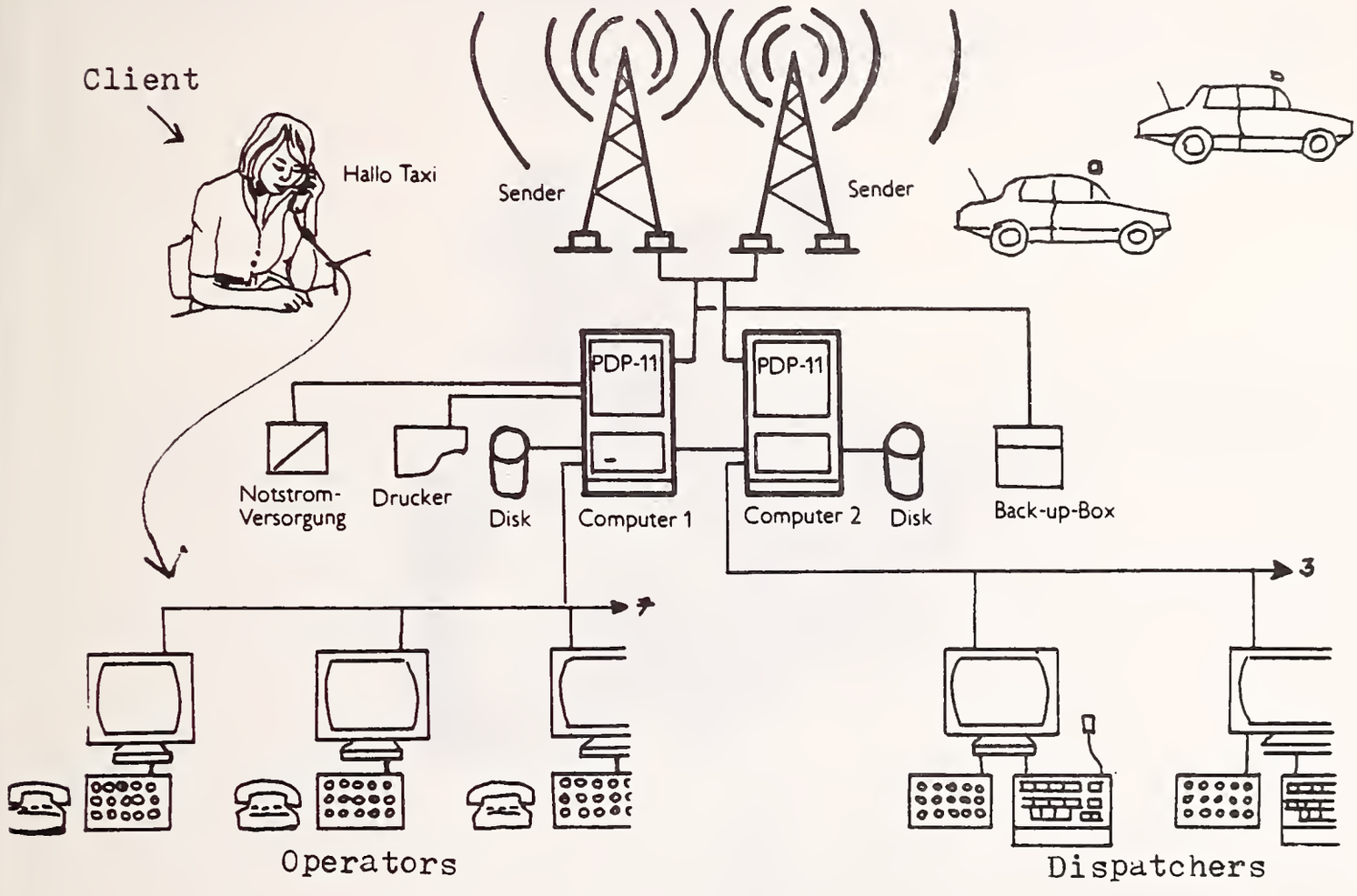
Figure 3-1: TAXICOM - GLOBAL SYSTEM STRUCTURE
(Telco Variant)



Source: Taxi-Zentrale Zurich

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If the reader will be so patient as to work his way step by step through the flow of activities and equipment suggested by the above, a first idea of how the system is intended to work should begin to emerge.

3.2. Pictorial Representation of TaxiCom Order/Service Process

To make this yet more clear, the following cycle of illustrations shows step by step how a typical TaxiCom installation works in actual practice. And while it does not by any means provide a complete definition of all of the different systems on the market and of all of their parts, variations, and potential extensions, this eleven step summary should nonetheless be useful by way of general introduction.

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Figure 3-2: CUSTOMER ORDER PROCESS

The operator enters the address into the computer, followed by optional information such as customer name. Advance bookings also request the pick up time.

Step 1: Customer calls Taxi Central and orders taxi.

Step 2: Operator enters order into computer, eliciting details from caller following prompts on screen.

Step 3: Computer verifies address and searches for free vehicle in vicinity.

Step 4: Operator informs customer immediately status of order (i.e., accepted, not accepted, expected time of pick-up).

Source: Graphics by VTS in Figures 3-2 to 3-6

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Figure 3-3: COMPUTER SELECTS VEHICLE

Step 5: Computer scans its memory and chooses most suitable vehicle to fill order. (This might not be the closest free taxi, for customer may have special requests, like a need for a station wagon, wheelchair accommodations, help from driver, etc.)

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Figure 3-4: COMPUTER ROUTES ORDER DETAILS TO TAXI

Step 6: Computer relays order to selected taxi -- via relay base stations located strategically around city.

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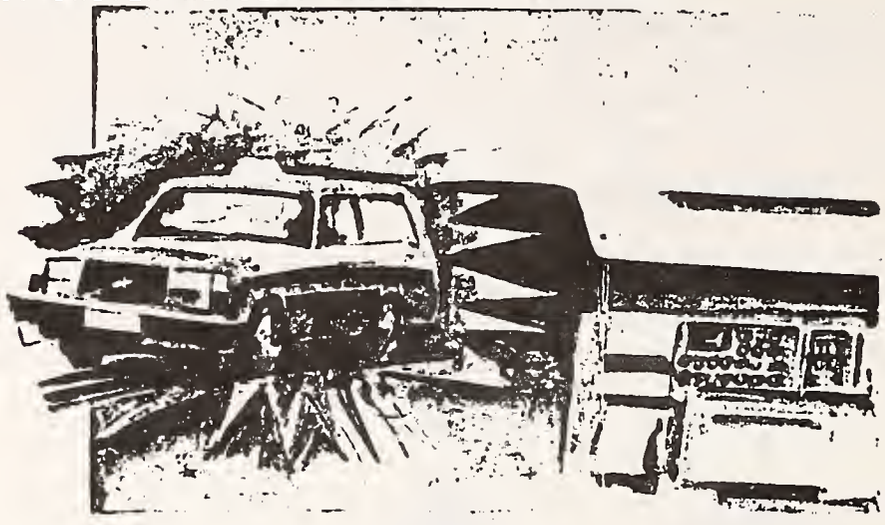
Figure 3-5: DRIVER REVIEWS ORDERS AND RESPONDS

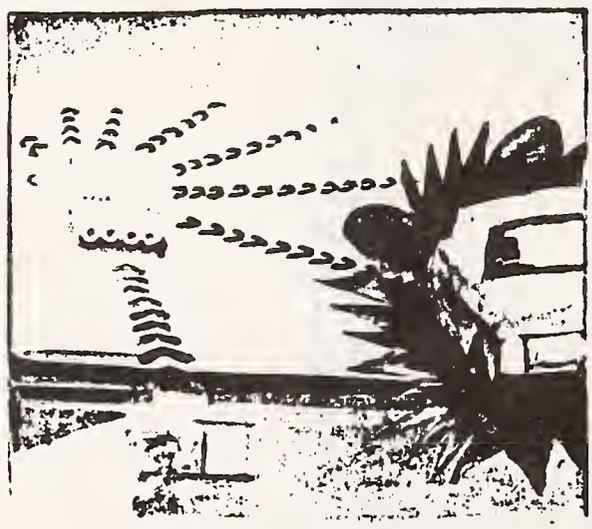


Step 7: Driver receives order on vehicle's printer or display unit.

Step 8: If he wants the order, driver pushes "accept button" and proceeds to customer's point of departure.

Step 9: If driver pushes "not accept" button, computer automatically transmits order to vehicle next in line.

Figure 3-6: CUSTOMER PICK-UP AND CONFIRMATION



Step 10: Driver picks up customer and keys in on his keyboard unit zone of the passenger's final destination.

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Figure 3-7: DRIVER SIGNS-IN WHEN FREE FOR NEXT RIDE

Step 11: As he approaches customer's destination, driver pushes "soon free" button. This informs the central computer the driver will be ready for another fare in minutes.

Source: Graphics provided by VTS.

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This of course is a highly simplified rendering of just one such system,albeit a highly typical one. In point of fact there are many other things that go on even in the simplest TaxiCom projects now in service, as well as a considerable number of variations from supplier to supplier and site to site. These will, however, become clearer in later sections of this report.

3.3. Passenger Perspective

TaxiCom offers customers an efficient and convenient way to taxi service. In point of fact the user will rarely if ever be aware of the workings of the system, though frequent riders should eventually be able to spot improvements in both availability and speed of service.

Three kinds of service requests can be handled by a full-featured TaxiCom system:

- Immediate pick-up requests
- Reservation service (for later pick-up).
- Standing orders.

The basic workings of these three types of service from the user's point of view are as follows. A customer in need of taxi service telephones the taxi dispatching center and, in response to the operator's prompts, gives the name, address, and any other special requests appropriate to his order. Thus, for instance, a customer desiring a station wagon or another special vehicle indicates this to the operator. Also, anyone with special handicapped transport requirements will make these known at this time as well.

If the call is for immediate pick-up, the customer is informed within a few seconds as to exactly how long his wait will be. If on the other hand the call is for service at some future time, the operator processes the information in the same way and the computer records the order. Again, the details of the order are confirmed immediately by the operator.

Standing orders, that is requests for regular service at specified times on a weekly or monthly basis, can either be handled as the above or, in some operations, by mail. Most TaxiComs give these orders highest priority, followed by advance reservations, with calls for immediate service having the lowest priority for guaranteed service.

From the customer's point of view there is, thus, little change in his usual routine for ordering a taxi. The sharp eyed observer may pick out a slightly larger and more elaborate "radio" console. His ears may be relieved by the absence of more or less continuous radio contact, static, etc., that can often be so irritating to passenger and driver alike. Either a small LCD screen or occasional hum of the printer and the sudden appearance of a small slip of white paper may be noted. But for the rest the user will probably not note anything special about this new system, at least as it presently stands.

That said, the advantages of such things as: (a) easier access to the dispatching center (i.e., faster pick-up of the telephone at the other end, fewer busy signals); (b) more rapid order taking and confirmation; (c) more precise information on pick-up time; (d) (possibly) more rapid pickup; and (e) more accurate dispatching (e.g., fewer routing errors), and (f) better management information on individual driver performance, should soon make themselves felt.

3.4. Driver Perspective

From the driver's perspective TaxiCom alters not only his working environment inside the cab but also the very method in which he operates over the working day. His vehicle itself does not look much different, of course, but the four big differences to the driver are:

- The system's potential for increased earnings and profits
- A rather more comfortable and safer working environment
- Some changes in work habits and routines
- The initial investment needed to pay for the system.

Taking the last of these first, the taxi driver and the owner -- increasingly in Europe one and the same person -- are those who are most directly and heavily effected by conversion to this new technology. TaxiCom conversion requires a not-inconsiderable direct investment -- currently in the range of several thousand dollars per vehicle for the necessary supporting equipment. It also usually means increased monthly fee levels for the radio dispatching service, since the new equipment at Central also needs to be paid for.

Who pays? For what? And when? These are all questions which need to be resolved concretely in each case, and which experience already shows are subject to considerable variations from site to site. Obviously, if the finances are arranged so that individual owner-drivers are socked at the outset with a three thousand dollar equipment bill and a pro rata payment on the various adds and ends needed at the Dispatching Center of possibly several additional thousand dollars, their resistance to TaxiCom conversion is likely to be enormous. And even where the deployment decision is going to be taken by a taxi fleet owner for whom the economic advantages of the new system (assuming that fleet owners keep better control of their accounts than individual owners/drivers) may be very clear, there still is a financial bullet of some proportions that needs to be bit.

But, as will be seen, there are a variety of options available to soften the blow and facilitate the financial aspects of conversion. Getting this part of any given TaxiCom project right is obviously going to be of utmost importance for its success.

Beyond this, TaxiCom conversion also requires a certain willingness on the part of the drivers to change working habits, not always the easiest thing to do, especially for the sort of highly independent personalities who tend to become taxi drivers. Agreeing to let the dispatching center know where he is at all times, permitting (eventually) a much closer check on his revenues, agreeing to give up his time-honored cruising or "homing" techniques to follow the advice of a "machine"... cannot be expected to occur without some resistance. Fortunately, on the strength of the experience accumulated to date it seems quite clear that those who are most directly affected -- i.e., the owner and the driver -- usually appear to feel that the benefits of TaxiCom substantially outweigh both its costs and other eventual disadvantages.

For the driver the most important advantage of TaxiCom is that it can help him to increase his occupancy rate and hourly billings; and at some times to cut down on "deadheading" and other unnecessary operating costs. The system can accomplish this through its ability to work in two main modes:

- Direct Order (A Stage-1 TaxiCom function)

- Recommendation Function (usually added later).

3.4.1. Direct Order Function

With TaxiCom the driver is not concerned with the technical details of telecommunications and order processing that go on before or after he receives from central a call for service. In point of fact, however, since in each project the owner/driver will have made his own decision to participate or not in the service, he will surely have learned in the planning and discussions stage for the conversion that back at central, from the moment the operator enters the order into the keyboard, the computer takes over.

Within his vehicle, he is of course fully aware of the new mobile terminal which now interfaces with his two-way radio which reviews and transmits all messages to Central. The terminal interfaces notably with the digital radio but also certain supporting peripheral devices (e.g., VDU printer, taximeter, credit card reader ... what have you) and incorporates all functions necessary for data transmission over the radio channel: radio modem, data formatting, error correction, acknowledgement and retransmissions. As will be seen, there are a number of ways in which this equipment can be configured and made to work.

The driver first becomes directly aware of the system's operation, only when a message is delivered over his vehicle's printer or monitor. (In the Taxi-80 variant this incoming message also causes the light on the top of the taxi to flicker, so that even if the driver is not in his cab he will still be able to see that he is receiving an order.)

At his convenience the driver is then able to read the message, which contains the customer's zone number, address, name, the dispatch number and other relevant data for his pickup. He is thus spared the confusion of deciphering radio orders, for one of the main objectives of this system is to do away with the distraction and ambiguity of radio communication. He also is pardoned the continuing noise of radio contact, much of which has nothing to do with him.

Communication with Central is facilitated by a series of buttons on small console. Again, the details of this do vary from project to project. In most, the driver notifies the Central that he accepts the fare by pushing an "Accept" button, and then proceeds to the address. Depressing the "Not Accept" button signifies that he does not want the fare. The computer then automatically selects and contacts the next closest taxi.

The following photograph shows the eight buttons on the Taxi-80 mobile unit which are pre-programed with routine messages to provide a direct and unambiguous method of communicating a taxi's most common situations. These communications thus take place by digital rather than voice channels, permitting much more effective use of scarce radio space. Also pictured is the printer on which the driver receives all messages.

Figure 3-8: ON-BOARD COMMUNICATIONS UNIT
(Taxi-80)

AC - Accept Button

NAC - Not Accept Button

->I - Soon Free Button

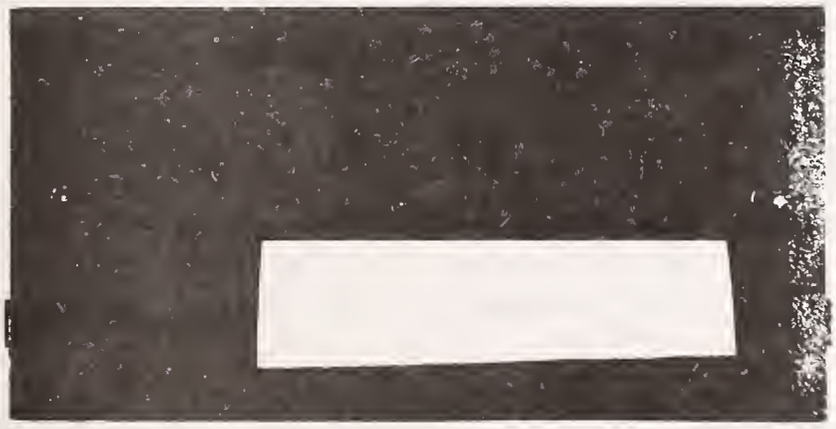
FIX - Received a Fixed-Price Trip

=<] - Speak to Control Button

GAR - Going to the Garage

PAU - "Pause" status - i.e., Unavailable for Customers

R - Available Again



Source: V + S

As soon as he picks up his fare, the driver immediately punches in a numerical code indicating the passenger's intended destination zone. This code is determined by consulting a special map which has been prepared and divides the city into a series of sectors, which are further divided into main zones and subzones. These divisions are based on careful prior study of operating procedure and traffic patterns: at the same time, they should fit well with widely shared local conceptions as to how the operating area is sectioned (i.e., by known neighborhoods, "arrondissements". etc.).

Incidentally, the level of expertise needed to accomplish this particular task currently right is considerable -- and one of the critical jobs at the operation's planning stage is to ensure that this is done well. Of course, once done, the task does not have to be repeated. (That said, a poor job at this stage is certainly not going to help the system, especially in the rough early days of breaking-in and acceptance by both the public and the operators.)

An example of two such maps, as developed by Volvo for Taxi-80 operation in the city of Gothenburg, and by Telco for Zurich, are reproduced below.

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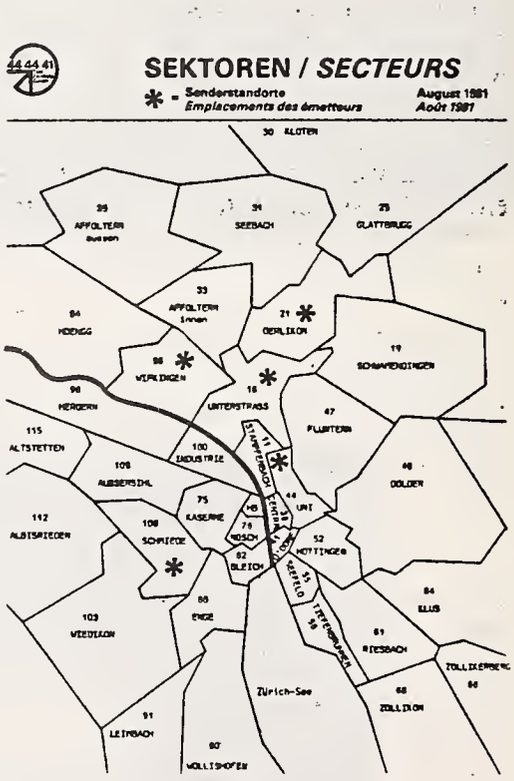
Figure 3-9: TAXICOM ZONAL DIVISION OF A CITY

Gothenburg

Zurich



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When the driver punches in his intended destination, the computer is informed of the zone where the taxi will next be free, and is further able by consulting the built-in traffic algorithm to derive the approximate time of arrival. As the driver approaches the final destination, he hits the "soon free" button which informs Central that he shall shortly be ready for another customer. (Note: Not all TaxiCom variants presently offer this feature.)

Every taxi in the system follows the same basic routine. This permits Central to be aware of the general location and status of virtually every vehicle participating in the city. This information, along with the continually updated and expanded data base on order origins, and its built-in "knowledge" concerning the city's traffic and taxi patterns, allows the central computer to "orchestrate" the taxi system in an entirely new set of ways.

3.4.2. Recommendation Function

Up to now we have dealt with the system's role in getting drivers directly and quickly to ordering clients. However, useful as that is, a fully developed TaxiCom will also able to provide drivers with yet one more kind of help -- the so-called "Recommendation Function". In this mode TaxiCom relays to a waiting driver with no fare, an indication of where he should head next in order to have: (a) the highest probability of obtaining a fare, and/or (b) minimizing the distance he will have to travel to the area where he is most likely to find his next fare.

This is dubbed the Recommendation Function because the driver has the option, but not the requirement, to head to these more strategically placed zones which are determined by the computer. He would do this rather than following the more conventional and time-honored options, i.e., heading to the nearest taxi stand, rail station, activity node, or simply cruising the streets for a fare.

The problem with this sort of traditional behavior is that most drivers inevitably tend to head to the same nodes. This leads to a clustering of vehicles and an over-supply at certain places, and a virtual taxi Sahara elsewhere. Moreover, it tends to exaggerate need for unnecessarily long trips to pickup radio calls from those few well known points to the actual point of demand.

The Recommendation Function should, we believe, be viewed as a second stage TaxiCom service. It builds directly on the expertise and data base accumulated over a certain period of time as the result of actually operating the service in the Direct Order status -- and, as such, is probably best brought into service not at the outset but only after at least several months of successful operation of the basic Direct Order mode.

Moreover, inasmuch as the Recommendation Function calls for drivers to alter quite radically their operational patterns -- something that experience shows is not always easy to obtain -- it is preferable that this stage be engaged only once the system has already proven its worth to them in the Direct Order mode.

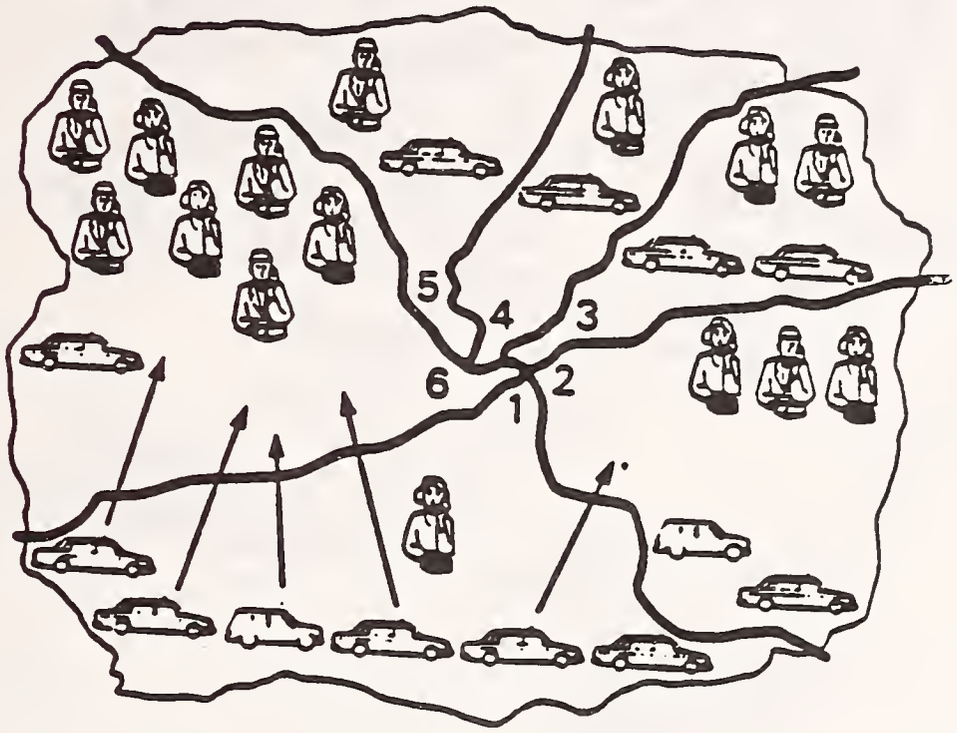
As part of the preparation for TaxiCom, the central computer can be programmed to calculate automatically the demand level for taxis in different areas of the cities, and for different times of the day. By dividing the service area into a series of probability zones, the computer can then use this information to decide on the optimal distribution of taxis.

The following set of diagrams show how the Recommendation Function works. This first rendering is meant to illustrate how, prior to TaxiCom implementation, a fleet of vehicles is randomly distributed around a city at a given moment of a given day. That is, where each vehicle happens to be parked and waiting for a customer, or where it is cruising or at work. In this example, we see a fleet of 13 taxis in a city which has been partitioned into six zones.

Figure 3-10: RANDOM DISTRIBUTION OF TAXIS AT 3:00 PM ON DAY 1

The next figure shows how the drivers redeploy their vehicles when informed by the dispatching center of the various orders throughout the city.

Figure 3-11: REDISTRIBUTION REQUIREMENT AFTER 3:00 PM ON DAY 1



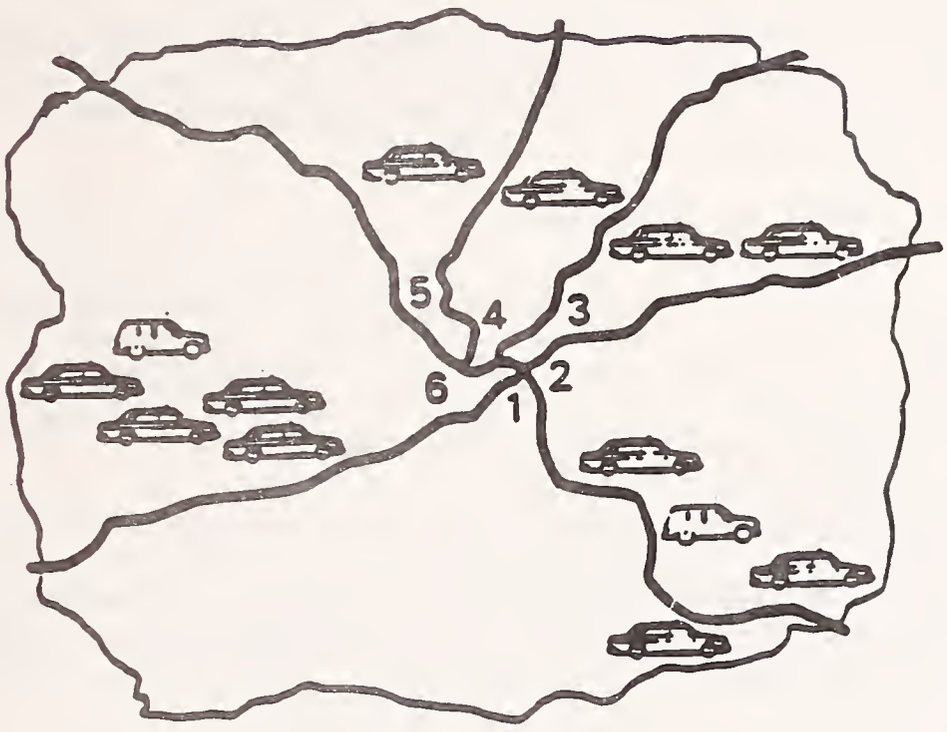
As a result of the information transfer plus fleet redistribution process that now takes place, we next see in our example how the taxis arrive at the needed service points.

Figure 3-12: TAXI DISTRIBUTION EQUILIBRIUM AT 3:30 PM ON DAY 1

And while all of the above cycle of activity can be achieved either through conventional radio dispatching techniques or -- more efficiently -- through a computer-based digital radio system like TaxiCom, what the next diagram shows is how the Recommendation Function can in due course "advance manage" vehicle distribution over the map of the city in an optimal way. Based on a built-in routing algorithm, which itself is derived from the detailed prior study of taxi user demand patterns in the city, vehicles can thus be pre-assigned to, or close to, the likely demand areas so as to minimize access time once orders are actually received.

As the following diagram suggests, once the Recommendation Function is fully up and working TaxiCom can use its computer capacities to process the historical data which the system itself has generated as part of its normal operations to make intelligent guesses as to where the demand for taxis are most likely to occur at any time of the day.

Figure 3-13: ADVANCED-MANAGED TAXI DISTRIBUTION AT 3:00 PM ON DAY 2



As experience with a given TaxiCom service accumulates, it not only continues to make use of its own planning data, but also is able systematically to update and expand its database and demand analysis. The more data available to TaxiCom and its managers -- that is, the longer the system has been operating -- the more effective the advance deployment of the vehicles over the map of the city. Thus, TaxiCom enjoys an inherent system of self-generating improvement -- an attractive feature to all concerned.

3.4.3. Safety and Security

Taxi drivers are well aware that their profession can be a dangerous one. Not only do they have to bear the risks of working all day long in traffic, but also they are all too often faced, all too often, with problems and threats of other sorts.

Some TaxiCom systems, thus, aim to offer greater security to the driver, as well as to the passenger. To this end the mobile unit in each taxi is equipped with both a voice radio and a hidden emergency button. Should verbal contact ever be desired or necessary, it is available in addition to the digital communication.

The emergency button, when activated, enables Central to monitor everything that is said within the taxi. This allows the dispatcher to establish the exact nature of the emergency and act accordingly.

Both of these factors complement information the computer may already contain which could be very helpful in an emergency, namely: the address the passenger was picked up at, his reported name as well as the zone of the intended destination. This can make pin pointing taxi's location much quicker and more accurate, and allow emergency help to be directed to the spot.

In grave cases the dispatcher may (in some systems) be able to channel the conversations within the signalling vehicle directly to both the police and to all other taxis on this system, to permit maximum assistance in the event of severe emergency.

3.5. Operations Center Perspective

TaxiCom is a computerized vehicle dispatching and management service. In order to keep a given TaxiCom up and working, two types of central functions must be kept up and coordinated on a continuing basis:

i) direct communications and dispatching; and

ii) a wide variety of supporting administrative tasks.

The former need to be carried out continually and on an "on line" basis. Nearly all of the latter can be handled by the computers and Central staff on a "when available" basis.

3.5.1. Communications and Dispatching

3.5.1.1. Equipment

Once converted to TaxiCom, the typical dispatching quarters of a taxi business are upgraded into a computerized control room. The control center now contains the host computer(s) which provides the core of the system; all other components are directly attached to it and function according to the central computer's directions.

This computer, until now always a minicomputer on the order of a DEC PDP 11/44 or Honeywell DPS 6/76, * houses all operations software including the geo-file database, and controls all information flows within the system between order takers and drivers. In addition to the order taker/dispatcher terminals (of which there might be, typically, half a dozen or so for a 400 vehicle fleet) there will also (in some systems) be a supervisor terminal and one or two printers.

Connected to the terminal is a communications control unit which acts as the primary interface for all information flowing between the mobile data terminals and the computer itself. This subsystem will normally comprise one or two modems and a base signalling unit (BSU). Under normal conditions, depending on details of the specific equipment and operations configuration, a single channel will be able to accommodate somewhere from 200 to 350 taxis (in the data mode). The function of this unit is not only

to process the necessary data flowing in and out of the computer but also to perform error checks, automatically request message retransmission in the event of error, provide a message buffering facility and keep proper track of simultaneously transmitted messages intended for different mobile units is a central and critical function of the systems.

In addition to the above, the well equipped TaxiCom control center will also have:

- Magnetic tape sub-system

- Maintenance test equipment.

3.5.1.2. Operations Routines

The entire service cycle is initiated and brought into play by the order takers/operators who man the control room. Each is stationed before a video terminal which is hooked directly to the computer. Communication with callers is facilitated by a telephone headset.

The TaxiCom operator receives the incoming order for service, and enters it directly into the computer, responding to a set of prompts which appear on the console's screen. This system ensures that no vital information is omitted. The average order takes anywhere from ten to twelve seconds, though during peak times individual operators in several existing installations have shown themselves as able to handle up to 12 call per minute. (As opposed to an average order processing time under conventional radio dispatching services of anywhere from forty seconds to two minutes, and more.)

The following illustrations show a series of display screens that represent the most common situations the operator encounters and how they are dealt with in a typical Taxi-80 installation. These outline the basic principle, which of course varies according to the individual TaxiCom system.

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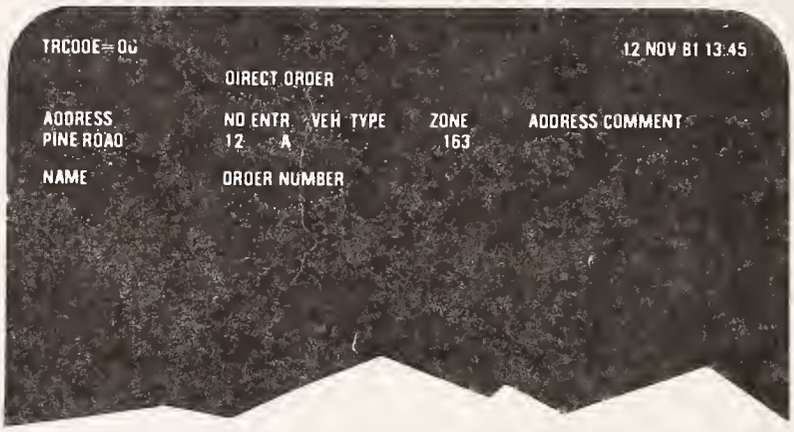
Figure 3-14: ORDER DISPLAY SCREENS: OPERATOR'S VIEW

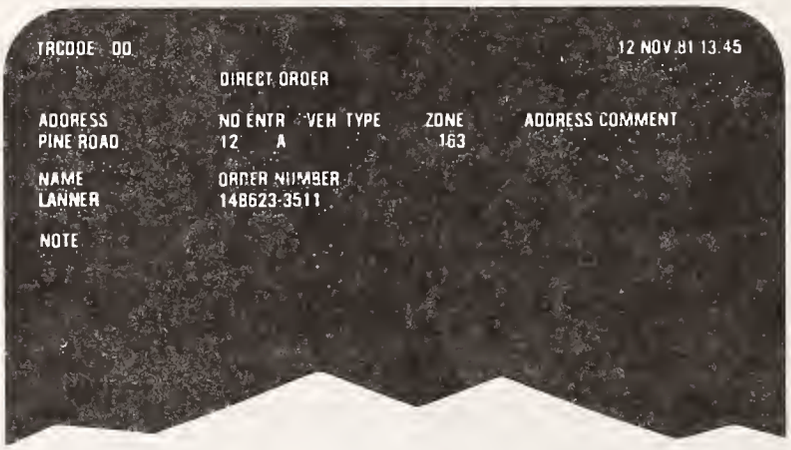
1) Operator view of display screen when user calls for service.
   Operator enters pick-up address.

- Figure continues on next page =>

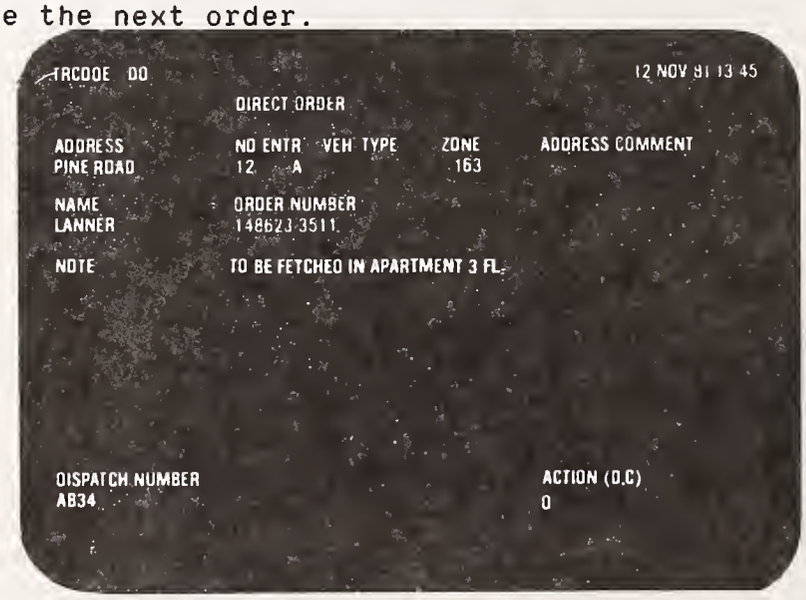
2) Computer responds to operator's entries by giving new prompts. In this case, the name is requested.



3) Operator enters name and any other information, such as ...



4) ...a message to the driver specifying that the passenger is to be picked up in his apartment. Once this is completed, the order may be processed, and the operator is available to handle the next order.



Source: Graphics supplied by VTS

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Both immediate reservations and standing orders are handled in basically the same way: the operator simply enters the date(s) and time(s) the taxi is requested at the time of initial processing. The computer then automatically notifies the operator how many other reservations there are at the same time, and at the appropriate time, dispatches an order to the most suitable taxi.

Advanced reservations usually have priority over calls for immediate service, and standing orders have priority over both of the above.

Some systems, for example Taxi-80 and AP-Tax, combine the telephone operator and dispatcher function. By contrast, Telco in Zurich has six work stations for the former and three separate dispatcher installations. Both points of view are vigorously defended by their proponents.

3.5.2. Base Stations

Only the smallest of communities are going to be able to execute a TaxiCom system from a single, central radio site.

In most places, relay facilities are going to be required to ensure that messages are accurately transmitted between the dispersed vehicle fleet and the dispatching headquarters. In the thirteen European installations planned and built to date, there have been between three and fifteen such facilities required.

Since many conventional radio dispatching center also require base stations, these stations may already be in place. In such places, TaxiCom conversion will require nothing more than the addition of appropriate new equipment to permit proper handling of digital messages.

A typical TaxiCom base station will have, in addition to an antennae for mobile radio pick-up, a direct telephone modem link to Central. It works as a modulator/demodulator to convert data from modulated analog to digital (and vice versa) depending on the direction of the information flow. The unit must also be able to inform the mobile terminals when it is busy, and to keep them from sending in data uselessly.

3.5.3. Fleet Scheduling

One of the tougher challenges of taxi fleet management is to determine the "right" number of taxicabs to put on the streets at any given time of day. To be sure, this is a problem which has just as many political aspects as it does technical, and which in any event is only relevant when there is some means for actually controlling these numbers (i.e., either where the vehicles are fleet owned or where there is some means of collaborative decision-making).

In many cities there will often be an excess supply of taxis over much of the day. This means higher costs to owners and reduces the net revenue potential for both them and the taxi drivers. Some variants of TaxiCom can help not only in getting taxis to users but also in overall fleet management and scheduling as well.

The following diagram shows how one TaxiCom (in this case Volvo's Taxi-80 system) approaches the challenge of improving the match of taxi supply with demand.

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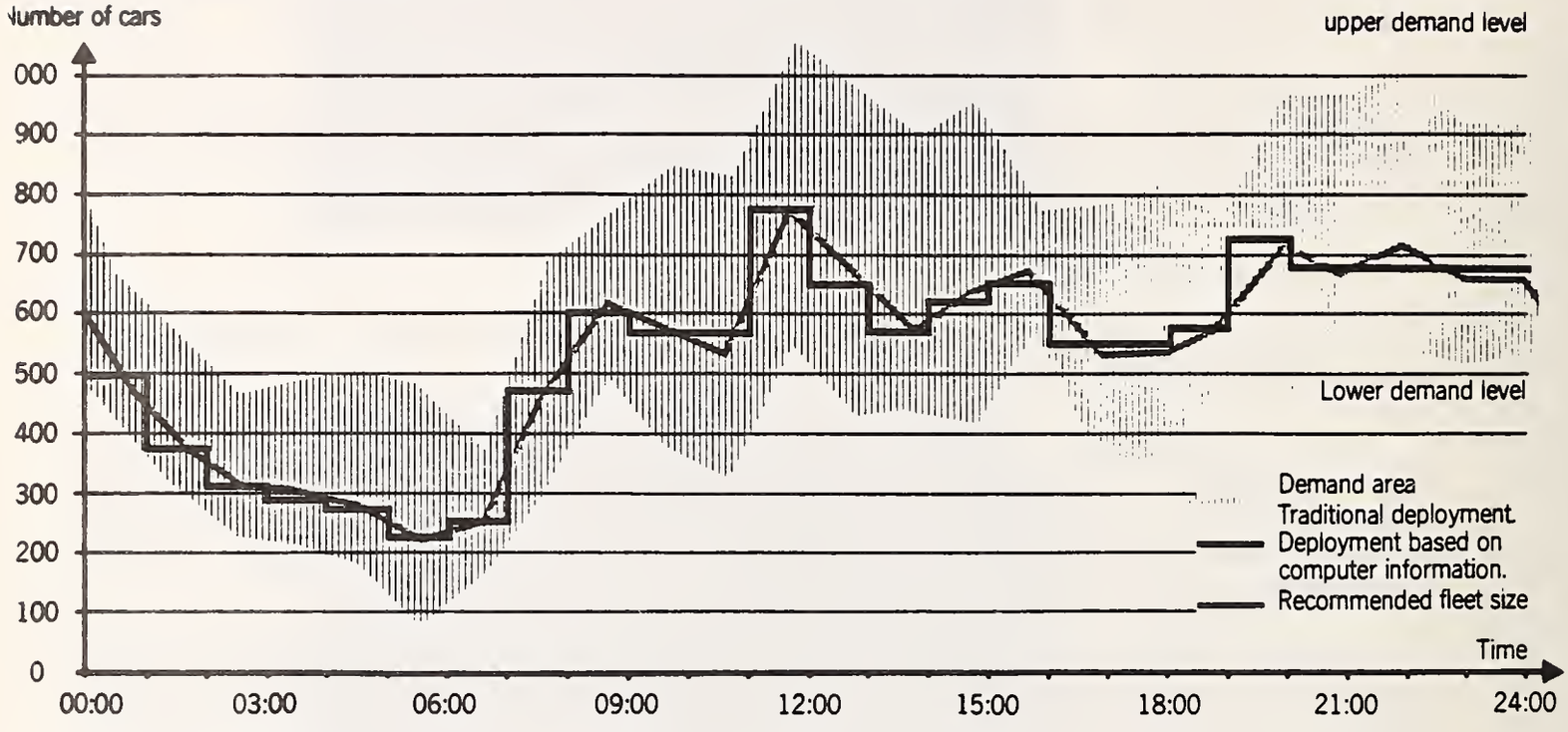
Figure 3-15: COMPUTERIZED FLEET MANAGEMENT GUIDELINES



Source: VTS

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By automatically processing management information which is generated by the system, the TaxiCom central computer can calculate the likely demand for each half hour period during the day for each service zone. This information can then be processed in order to determine the number of vehicles needed to meet the city's changing demand throughout the day. This aspect of TaxiCom can provide a considerable improvement over traditional methods of determining fleet size and distribution both overall and hour by hour throughout the day.

Of course, the computer's suggestions are only that; they are meant to aid the dispatcher in the final distribution decision. Bad weather, huge sporting events, and the like are variables the day-to-day algorithm will not know about, and its suggestions must be adapted accordingly. These adjustments may be introduced either on a judgmental basis or, eventually, entered into the database itself.

3.5.4. Supporting Management Functions

In addition to the above, Central must be able to perform a wide variety of supporting functions. Chief among these, we would note:

- planning;
- program maintenance;
- program extension;
- statistical analysis;
- routine administrative functions.

Among these last are, of course, such vital business processes as accounting, billing, personnel management, payments, et al.

One of the main objectives of TaxiCom is to devise a system which will be capable of handling all of these critical tasks smoothly and as part of the normal routines. For this to be able to be achieved fully and effectively, good use of both the system's hardware and software in practical daily routines is critical.

Actually achieving high levels of performance in these tasks is far from self-evident. It will require a detailed understanding of both existing operational requirements and of the ability of a fully computerized operation to deal with these. In many ways, these tasks are, on the surface, irrelevant to TaxiCom's immediate objectives -- i.e., as a dispatching tool only.

In actual fact, it will often turn out that a certain level of computerization already exists in the operation which is considering TaxiCom conversion. More likely that not, though, what is already in place will have come about as a result of piecemeal measures, usually beginning in areas of accounting and payroll.

The time of TaxiCom conversion provides a unique opportunity for re-addressing the entire management information requirements of the taxi operation in all of its aspects. And while expensive and time-consuming, it would be a great waste not to profit from this once in a (business) lifetime opportunity.

4. THE EUROPEAN TECHNOLOGY SOURCES

The following chapter introduces the main European technology sources for TaxiCom, briefly recapitulates the history of their respective development programs, and closes with some notations concerning the distinguishing characteristics of the particular technology and operations approach they are offering on the market today (i.e., with reference to the benchmark TaxiCom description that appears in the preceding chapter).

The reader is forewarned that these technologies are in quite different stages of readiness with respect to their preparation for being bought on line in a new site. The following descriptions should help to make this clear and, in any event, full particulars can be obtained by contacting the indicated references.

4.1. Volvo Transportation Systems Corporation: Taxi-80

4.1.1. Background

The origins of the TaxiCom movement in Europe can be traced back more than a decade to the laboratories of the Volvo Corporation and the streets of the city of Gothenburg in southern Sweden. The proprietary TaxiCom system which came out of all this development work, and which is now operating in a steadily expanding number of Scandinavian sites under the name of Taxi-80, is in many ways a direct descendant of an earlier paratransit research and development project called "Telebuss" which had been originally initiated by Volvo in the early 1970's.

Telebuss was a relatively ambitious technology-based Dial-a-Ride system which aimed to combine a fleet of small buses, a proprietary routing algorithm, on-board radios, and a computer-aided central dispatching system in order to provide a flexible transportation service for the lower density suburban areas which are usually so poorly served by conventional public transportation systems. Like many of the European R&D efforts carried out in the sector at the time, Telebuss leaned heavily on the American Dial-a-Ride experience of the late sixties and early seventies.

The test runs with Telebuss at Volvo and later in a limited pilot project in Boras, Sweden, showed that the basic operational concept and the supporting hardware behind it were generally viable. However, for a variety of reasons no effort was made to follow up on the technology at that time, at least as a bus system. In the event, much of the technology developed for Telebus was later refined, modified and transferred to Volvo's new automated taxi dispatching system which eventually was to become known as Taxi-80.*

Against this background Volvo's Transportation Systems Group began in the mid 1970's to look into the prospects for applying the basic technology and organizational principles developed with their Telebus trials to the operational problems of taxi companies. Volvo's interest in taxis was also spurred at this time by yet another independent project within the corporation, which had as its objective to come up with a new, fully redesigned, purpose-built vehicle for taxi service. Volvo's new taxi was eventually to be demonstrated by two prototypes, one on which even spent some time at the Museum of Modern Art in New York as part of a design competition. As far as sales and production were concerned, however, Volvo never got the project beyond the prototype phase.

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* Among the reasons for the lack of follow-up at the time of what appeared to be a fairly promising technology and service package were: the lack of interest of the Swedish government to get directly involved in sponsoring any demos or even R&D in this area; the hard-headed attitude of Swedish transit operators who felt that DRT was nowhere near to being ready to help them in their priority concerns; and the unwillingness of Volvo itself to put any more money into a project whose market potential was far from self-evident.

The initial development period for this second stage paratransit technology project spanned three years, originally under the working product name of AVCS (a Swedish acronym for Automatic Taxi Dispatching System). Volvo worked alone on the project over the closing years of the 1970's, using the radio equipment of the SRA group, a small Swedish firm later acquired by L.M. Ericsson, Sweden's largest telephone and electronics manufacturer. The pace of development work was deliberate, and the whole program proceeded with the benefit of extensive collaboration with the local (Gothenburg) taxi cooperative.

Today Taxi-80, as the product is now known, is billed and marketed as a joint Volvo/Ericsson product. The latter's long experience as a supplier of telecommunication equipment of a variety of types, including mobile installations for police and emergency vehicles as well as taxis, appears to be a highly useful addition to the product package, both in terms of ensuring fully proven radio and microelectronic technology and for international marketing purposes. Volvo itself has been entirely responsible for the initial conception and global system design and development, as well as the traffic routing and dispatching algorithms which permit Taxi-80 to be adapted to new service areas quickly and at low cost. Ericsson Radio Systems supplies the new digitalized data transmission technology and the radio equipment. Together the two firms now offer a proven technology and operations package.

4.1.2. Present Status

The following figure shows at a glance the present status of Taxi-80 in terms of its actual deployment out in the working world.

Table 4-1: TAXI-80 OPERATIONS SITES

City	Country	Date Service Initiated	No. Taxis
A. Taxi Operations			
Gothenburg	Sweden	November 1982	615
Malmo	Sweden	December 1982	210
Stockholm	Sweden	May 1983	1725
Trondheim	Norway	June 1983	189
Boras	Sweden	December 1983	62
Baerum	Norway	March 1984	225
Bergen	Norway	February 1985	310
Linkoping	Sweden	November 1984	77
B. Other Applications			
Courier Service	Norway	November 1984	50

Taken together, these nine sites account for a total of more than 3,400 vehicles and a total investment cost of close to $14 million. With this by way of immediate background, it is clear that VTS is fast emerging as a major contender in this new market.

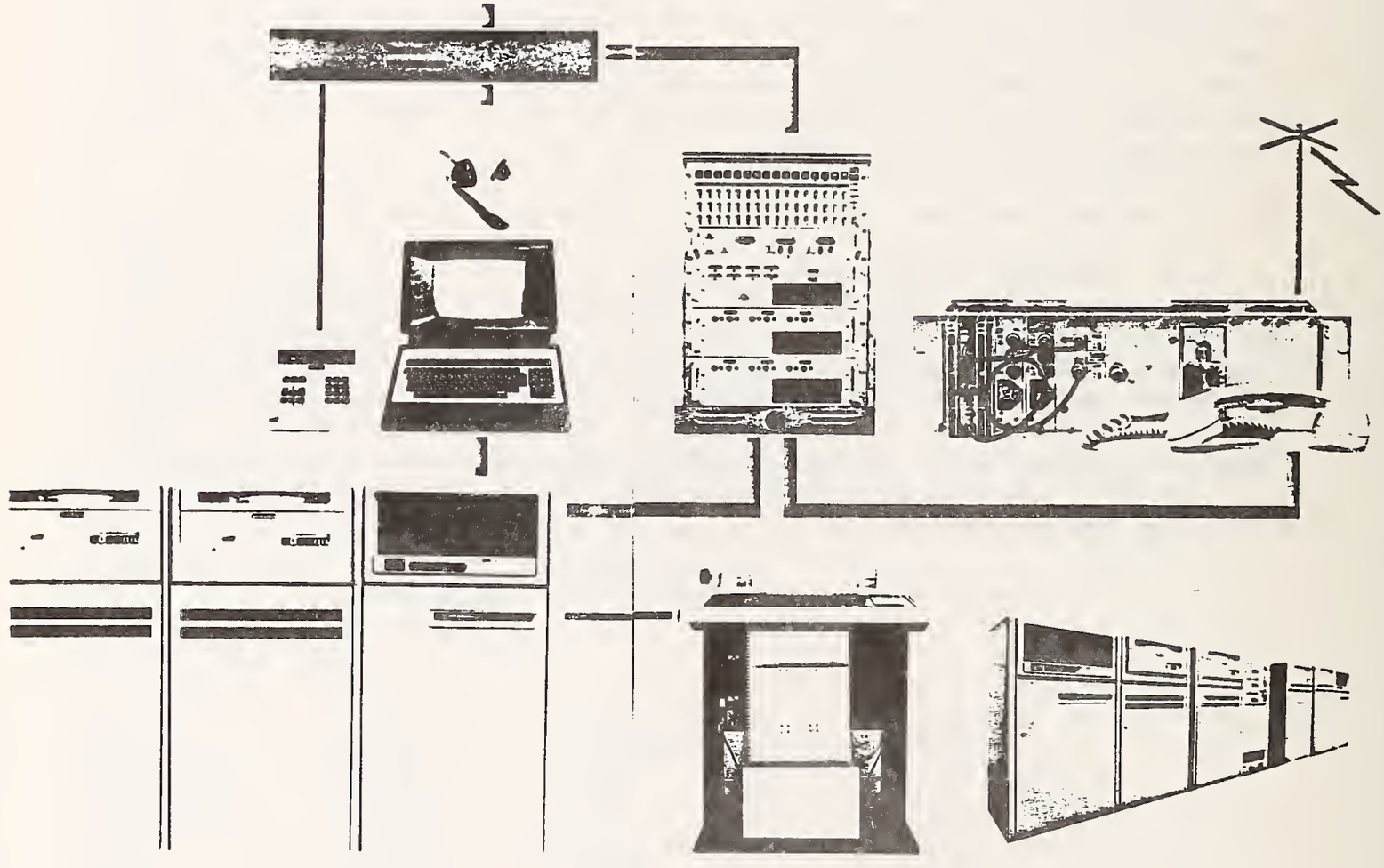
VTS is also in the process of developing a new project in the district of Lillehammer which will incorporate five townships. This particular site is being considered for the 1992 Winter Olympics; if it is chosen, it is likely that Taxi-80 will go on line next year.

It is obvious from this listing that VTS is at this stage concentrating its marketing effort on near-by Scandinavian sites. This seems sensible considering the consultancy component of any TaxiCom conversion costs is not trivial. That said, once VTS begins to be fully confident of their ability to adopt Taxi-80 to new sites at acceptable (and anticipatable) levels of cost we can expect to see the project's sponsors vigorously pushing its marketing effort in the rest of Europe and abroad. In the meantime, the company is keeping close track of opportunities on the international market and very much a force to be reckoned with.

4.1.3. Notable Features

The following figure shows the basic layout of VTS's Taxi-80 central computer control room. Briefly, the information flow through Taxi-80 is in the classic TaxiCom pattern: (a) Call comes to central switchboard and is automatically routed to the next available operator; (b) the operator takes the order and transmits it to computer for processing; (c) the computer then interrogates the fleet through its multiplex unit and radio base stations, and in two or three iterations, negotiates the driver assignment and contact; (d) this information is then transmitted to the operator and in turn to the ordering party.

Figure 4-1: TAXI-80 CONTROL CENTER LAYOUT



All Taxi-80 projects currently use Digital Equipment's PDP 11 series minicomputers. In three sites (Gothenburg, Malmo, Stockholm) these have been doubled up in the control center to ensure reliability. This also permits Central to use the free computer for many of the off-line functions which are important for the system's operation, while giving them as well immediate back-up in the event of the first computer's failure.

Each computer is equipped with two disc drives which are fully backed up. This allows for a total capacity of 28-122 Megabytes. CPU requirements are from 0.5-1 Megabytes. Depending on the particular computer configuration chosen, Taxi-80 can handle up to 2000 vehicles.

The following diagram shows three levels of system capacity, as associated with three different sizes of DEC minicomputers. As can be seen, the potential for scale economies of operation would appear to be substantial, especially as one scales up from the 150 taxi to the 1500 vehicle level. Of course in most cities, it will be at these lower levels of fleet size and demand that the economies of the system are going to have to work themselves out. As shall be seen, experience to date suggests that this is not going to be a problem.

Table 4-2: TAXI-80 COMPUTER SYSTEM/PERFORMANCE OPTIONS

Computer Equipment	DEC PDP 11/24	DEC PDP 11/44	DEC PDP 11/70
Max number of:			
Taxicabs	150	9000	2000
Radio Channels	3	8	15
Zones	100	200	300
Orders/hour	1000	1500	200
Terminals	8	16	25

Source: VTS

At present, Tandberg and Visual 200 terminals are those most often used in VTS's Scandinavian projects. These have been selected because they are:

a) VT 100 compatible (Needed for PDP computers);

b) Technically and ergonomically adequate;

c) Least expensive available in Sweden.

For a variety of reasons it will not be possible in most places for TaxiCom to beam radio signals directly from Central over the entire service area. Accordingly, a series of radio base stations usually have to be located throughout each operating area. These function as communication relay stations between the central computer and the vehicles.

The present largest system (in Stockholm) uses 13 such stations, which provide for a maximum area of service. Messages from the computer to the base stations are transmitted via a 4-wire circuit on basic telephone lines, and then are radioed to the selected cab. Transmission speed has been calculated at 1200 baud with normal digital communication.

In Gothenburg, the system operates with 6 channels on 450 MHZ; in Stockholm with 13 channels on 160MHz: and in Malmo with 3 channels on 150 MHz. Each channel is able to accommodate 200 taxis.

The following table identifies some of the key parameters associated with the two radio systems currently being offered in conjunction with the Taxi-80 deployments.

Table 4-3: TAXI-80 RADIO - SYSTEMS CHARACTERISTICS

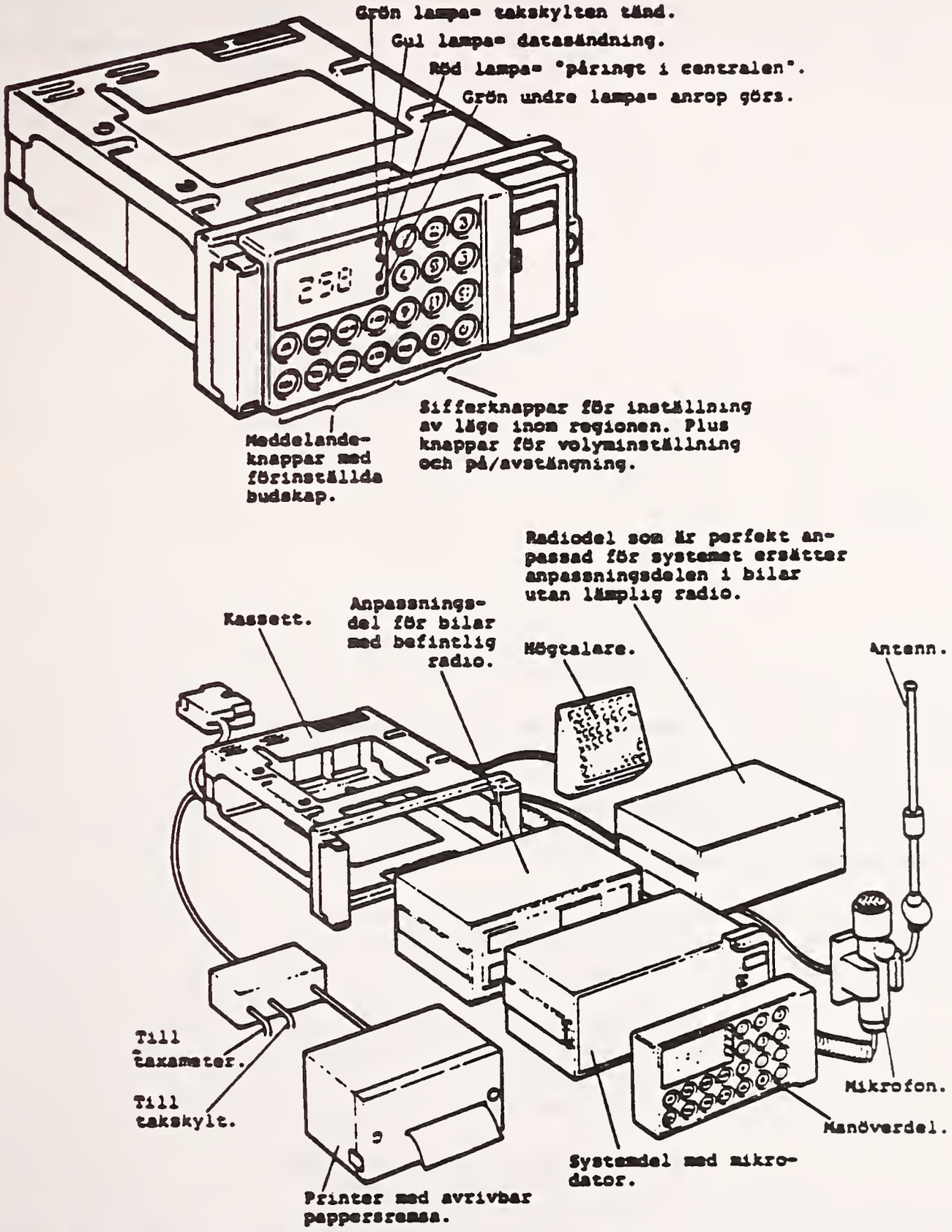
(Describing two "Ericsson Radio Systems" products)

Corresponding PDP Computer	11/14	11/44	11/70
	Model	F600	
Frequency range	66-88 Mhz	138-174 Mhz	380-470 Mhz
Number of channels	1-8	1-8	1-8
Sensitivity	0.35 uV	0.35 uV	0.35 uV
Output power	10/20 W	10/20 W	10/20 W
With amplifier	100 W	100 W	100 W
	Model	F700	
Frequency range	66-88 Mhz	146-174 Mhz	380-470 Mhz
Number of channels	4	4	4
Sensitivity	0.4 uV	0.4 uV	0.4 uV
Output power	20 W	15 W	6 or 12 W
With amplifier	100 W	100 W	100 W

Each Taxi-80 vehicle is outfitted with Ericsson's computerized mobile radio, the C600 Verscom. This unit also incorporates a printer and three integrated components: a transceiver, a logic unit-which contains the microcomputer, and the control panel. It is a small unit and can be fitted to the dashboard of most automobiles.

A pictorial representation of this unit appears below.

Figure 4-2: TAXI-80 MOBILE UNIT


Grön lampa= takskylten tänd.
Gul lampa= datasändning.
Röd lampa= "påringt i centralen".
Grön undre lampa= anrop görs.
Sifferknappar för inställning av läge inom regionen. Plus knappar för volyminställning och på/avstängning.
Meddelande-knappar med förinställda budskap.
Radiodel som är perfekt anpassad för systemet ersätter anpassningsdelen i bilar utan lämplig radio.
Kassett.
Anpassnings-del för bilar med befintlig radio.
Högtalare.
Antenn.
Till taxameter.
Till takskylt.
Mikrofon.
Manöverdel.
Systemdel med mikro-dator.
Printer med avrivbar pappersremsa.

The system is also equipped with a radio which can be used to communicate verbally with central, should that be desired. The radio has two alternating channels, and requests for verbal communication take about ten seconds.

The following table summarizes some of the main technical data associated with this particular manufacturer's offerings.

Table 4-4: TAXI-80 MOBILE RADIO SYSTEM DATA

Corresponding Computer	11/23	11/44	11/77
Mobile radio		Ericsson C600 Verscom	
Frequency range	66-88 Mhz	138-174Mhz	380-470Mhz
Mode of operation	One or two-frequency simplex and duplex.		
Number of channels	15	15	15
Min. channel separation	12.5/25 kHz	12.5/25 kHz	12.5/25 kHz
Bandwidth transmitter	(1.75 MHz, 2.5 MHz-3.5 MHz)(=>Dito)		(1.75 MHz,3.0 MHz)
Bandwidth receiver	(3.5 or 3+3 MHz)	(6 or 3.5+3.5 MHz)	(3 MHz)
Sensitivity	0.35 uV	0.35 uV	0.35 uV
Output power	20/10 W	20/10 W	20/10 W
Power supply	12/24 V	12/24 V	12/24 V
Weight	1.9 kg	1.9 kg	1.9 kg

To conclude this general introduction to Taxi-80, we would note the following:

- Taxi-80 is the only TaxiCom system other than AP-Tax (see below) which has opted to install a printer rather than an on-board Visual Display Unit or traditional radio.

- Taxi-80 has not only the largest number of installations in operating today, but also has probably invested more time and resources in developing their system than any other vendor to date.

- Taxi-80 has been extensively shaped as a result of Volvo's several years of close collaboration with three taxi operators.

---------- For further information on Taxi-80, contact ----------

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Product Manager

Mr. Claes Westberg
Vice President

4.2. Taxi-Zentrale: Telco

The first TaxiCom system implemented in Europe was the Taxi-Zentrale's Telco project in Zurich in 1980. Founded in 1966, the Taxi-Zentrale Zurich AG is a private company which today groups and serves 400 of that city's 1200 taxicabs.

4.2.1. Background

Beginning in 1976 Taxi-Zentrale's management was already on the lookout for ways of increasing central dispatching efficiency and to improve the earnings of both the taxi drivers/owners and the Zentrale. This leads them eventually to design a fairly simple, entry-level TaxiCom system which was first successfully tested in a pilot project in 1979.

By 1980 Telco was expanded to full service, covering the then entire 330 vehicle fleet and handling, more than 500 telephone orders per hour in peak hours. Taxi-Zentrale subsequently spun off a separate company, also under the name of Telco, to develop further the concept and to attempt to market it in other suitable sites.

The system offers taxi service 24 hours a day, and central is able to function with 4 - 6 operators per shift during the day, and 2 during the night shift.

4.2.2. Present Status

Telco has thus far had only a single application in its original version, as now in operation in Zurich. Recently they report having signed a contract with the city of Bern, Switzerland, for a Telco System to be developed toward the end of 1985. There have been numerous contacts with other cities in Switzerland and abroad but, as yet, they have led to no projects other than the supply fo Telco's vehicle display units (with the brand name of Indelco) to the Rotterdam TTC-Taxi project (see below).

The following table summarizes the situation with Telco deployments as of this date.

Table 4-5: TELCO OPERATIONS SITES

City	Date Service Initiated	No. Taxis
Zurich	1980	400
Bern	1985	n/a

4.2.3. Notable Features

Telco describes the highlights of its system as follows:

- TELCO'S taxi dispatching system is a complete application package, covering virtually everything needed for computer-controlled operation of a 100 to 2000 (or more vehicles) taxi business.

- It uses a DEC PDP-11 computer under RSX-11-M and the TELCO mobile radio and data communication hardware.

- Advance orders are processed automatically once they are entered into the system. Orders can be entered into the system up to 6 months in advance.

- Dispatched orders are transmitted to the selected taxi by radio data communication and displayed to the driver on a 20 to 40 character LED matrix display.

- The mobile data communication and display unit may store orders (information) up to 1000 characters until they are carried out.

- Special messages may be initiated by the cab driver to get to know areas, respectively sectors, where he can expect to receive an order sooner.

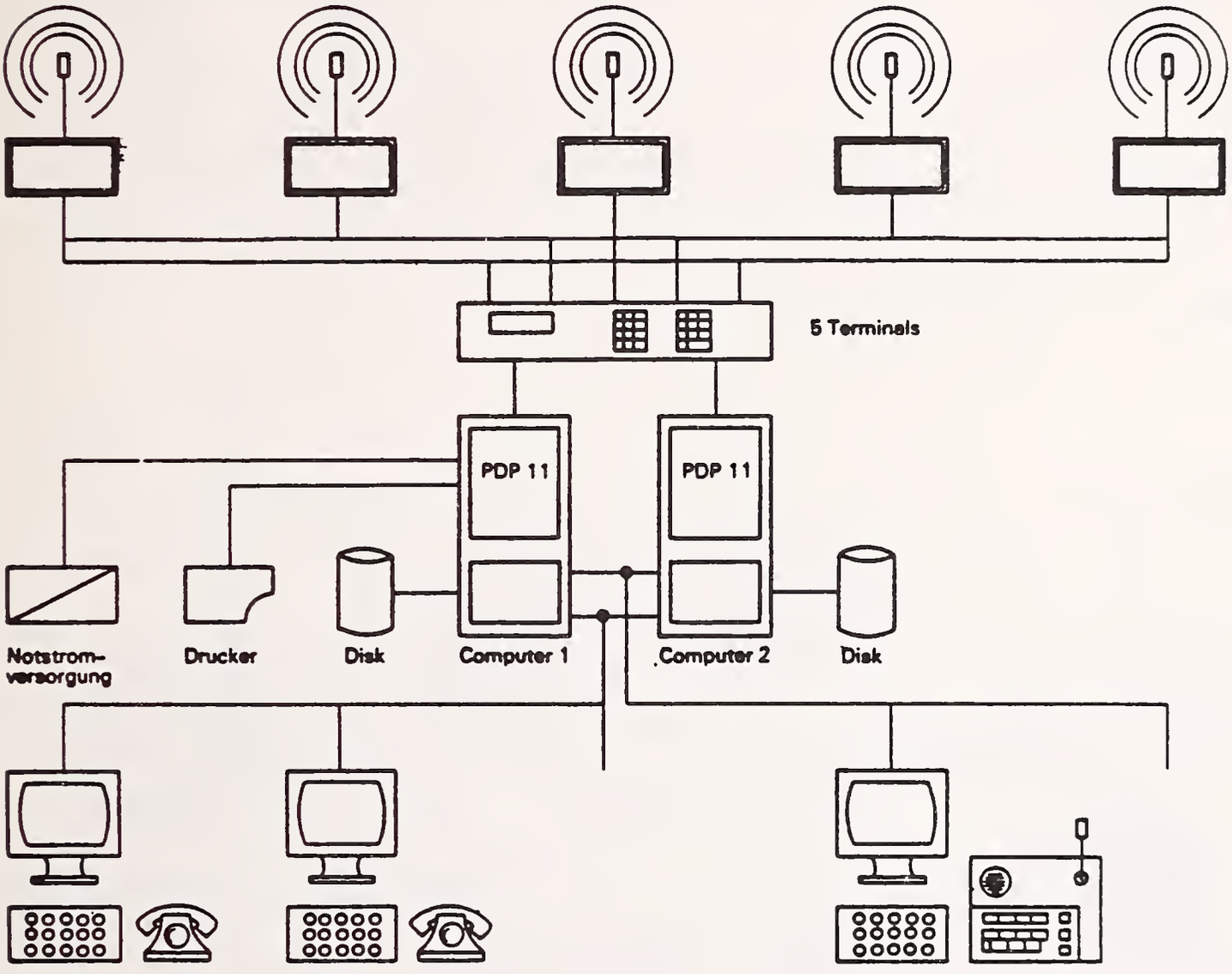
- The system provides also voice communication between the dispatching center and the cab drivers. In this case, the system operates like a mobile telephone system. Besides communication between dispatching center and a particular taxi-cab, there are also different kinds of group-calls and a general call provided.

- Special facilities are provided to the dispatchers to handle (spoken) inquiries by the drivers, to have particular information displayed or searched for.

- The system features also programs for statistics and optional subsystems for credit card processing, general ledger, etc.

The following diagram shows how a Telco control center is laid out, and as such provides a good general representation of the major equipment components and information handling for this slightly different system.

Figure 4-3: TELCO CONTROL CENTER LAYOUT



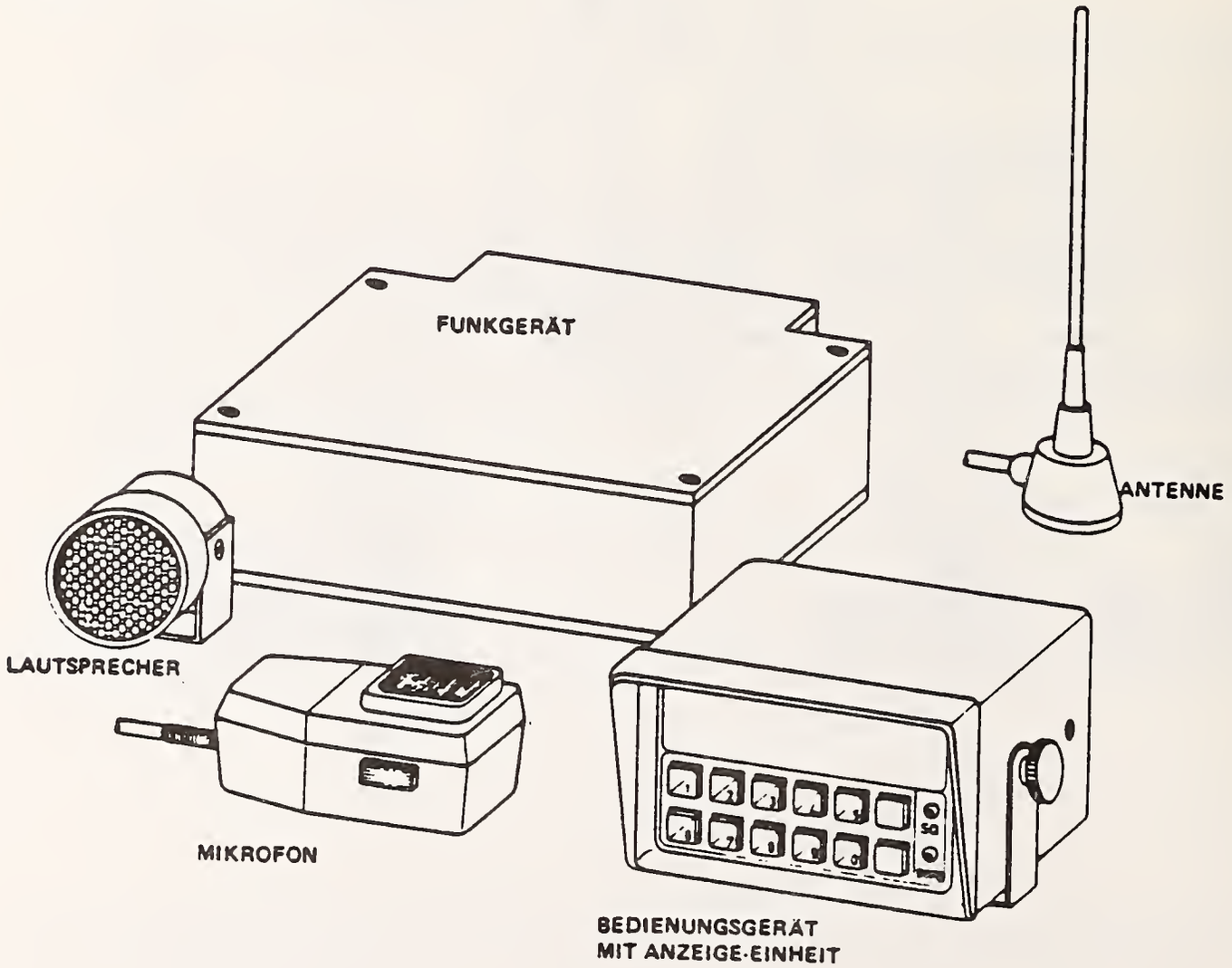
Like Taxi-80, Telco uses DEC PDP computers. The following table shows three levels of system capacity that they associate with three different DEC mini computers.

Table 4-6: TELCO COMPUTER SYSTEM/PERFORMANCE OPTIONS

Computer Equipment	DEC PDP 11/23	DEC PDP 11/24	DEC PDP 11/44
Max number of:			
Taxicabs	50-200	150-1500	1000-3000
Radio channels	1-4	2-8	6-16
Zones	120	>200	Any #
Orders/hour	900	2000	>2000
Terminals	up to 8	up to 14	up to 48

The mobile units for the Telco system are somewhat different from the Taxi-80 unit, as the following diagram suggests.

Figure 4-4: TELCO MOBILE UNIT



Price information here has changed somewhat since the system went on line. The mobile units, for example, have decreased to 4,500 SF. Telco also reports that today their two DEC computers can be replaced by faster and cheaper models.

The subscription rate to the Telco system for taxi owners is 475 SF a month, the same price that was paid before Telco was installed.

Six fewer people are needed to operate Central; Telco thus is able to save 250,000 SF/year in salaries. Furthermore, Telco reports that the working environment in Central, as well as in the taxi, is much more "human".

Telco has calculated revenue per taxi on a Swiss Francs per kilometer basis; this figure rose from 1.55 SF to 1.64 SF with the new system. What this means is that on the average, each taxi is now earning 1.64 SF for each kilometer of driving. This is the total average figure, and includes both deadheading and revenue kilometrage. One factor causing the increase can be traced to the decrease in deadheading, which is what lead Telco to conclude, as mentioned above, that there was "Less deadheading".

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To conclude this general introduction to the Telco project, we would note:

- The Telco variant in Zurich is somewhat simpler than either Taxi-80 or AP-Tax, although the Dutch Rotterdam variant is apparently trying to develop a more extensive and sophisticated system.

- More generally Telco has, thus far, been much less aggressively marketed than either the Volvo Taxi-80 or AP Radio/Philips AP-Tax approach. This would appear to flow directly from the interest of the original project: Volvo and AP Radio were both seeking to develop a commercial product with wide spread application, while Taxi-Zentrale, like Computer Cab, was trying to solve a specific (its own) set of operational problems.

---------- For further information on Telco, contact ----------

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Project Manager

Mr. W.H. Fuchs
Commercial Manager

4.3. Computer Cab

4.3.1. Background

Computer Cab is a radio dispatching service in London which is a wholly-owned subsidiary of the London Taxi Drivers Association. The Licensed Taxi Drivers Association is a co-operative of some 5000 licensed cab drivers. It offers a wide range of services to its subscribers including personal health insurance, legal advice and credit union facilities. It is recognized by Government as the primary representative organ of the London cab trade.

Computer Cab has spent several years in designing and implementing their own purpose-built TaxiCom service. Their main goal is to install in each taxi the mobile units necessary to participate in the computerized dispatching process.

The Computer Cab TaxiCom project went live in 1983 and was fully on line by the middle of 1984. Planning began in 1981. Computer Cab, previously only one of several radio dispatchers, is responsible for all systems and software development. At present the system handles 1600 taxis (1150+ Central and 350+ Suburban) through eight radio channels and is growing rapidly.

Drivers currently pay anywhere from £25 to £38 per month for the dispatching service, the latter figure including radio rental. At present Computer Cab is trying a free 3-month trial service, and in no event charge for either equipment or stripping.

The individual driver/owner subscription to the Computer Cab dispatching service has not increased with the addition of the new system. In fact, Computer Cab, has plans of reducing the monthly fee due to an increase of profits they have experienced since the system went in March 1983 on line and their desire to expand further their business base.

Computer Cab is, on the surface, the simplest TaxiCom variant to be developed to date. Their approach has been entirely site-oriented, and the development effort has centered on the task of trying to find practical, cost-effective solutions to the company's specific, current operating and dispatching problems (and opportunities) in the Greater London area.

To accomplish this Computer Cab has developed a three-phased implementation program which aims to achieve a smooth incremental transition from a traditional taxi dispatching outfit to a fully computerized and digitalized dispatching TaxiCom service. The first phase aims to move from the former conventional manual system to a fully computer-supported order taking and dispatching service, with all communication between Central and a taxi remaining verbal. The second phase is to bring in a sophisticated accounting program, which will allow the computer to handle increasing responsibilities regarding general accounts and billing procedures. The third phase will involve installing in every taxi a micro-computer based unit consisting of a new radio, taxi meter, data processing, and connections subsystems, complete with VDU, which will allow for complete digital communication between Central and taxis.

At present, Computer Cab is concentrating on the first phase, and is supporting it with a gradual expansion to the second phase. Phase three is still several years off, as Computer Cab is primarily concerned with expanding phase one to its limits before introducing the VDU.

There is also thought being given to yet further development and extension beyond this third stage. Until now, however, this has been confined to nothing further than informal brainstorming and information collection. That said, there is every reason to expect that this operation will continue to bring in new equipment and functions as technology moves ahead and as the company itself is able to assimilate the previous round of improvements.

4.3.2. Present Status

The following summarizes the current development status of Computer Cab.

Table 4-7: COMPUTER CAB OPERATIONS SITES

City	Date Service Initiated	No. Taxis To date
London	July - 1983	1630

One of the reasons that Computer Cab's development has been so rapid can be traces to the fact that Standing or Corporate Accounts are an extremely important part of the London Taxi business. This is creating a new market for taxi services -- and, along with it, a new set of service requirements. (These jobs pay considerably better than street work.)

Since this system has been entirely site motivated - that is, Computer Cab developed this system to address its own specific requirements and opportunities in London -- there have as yet been no other applications of this technology to date. The interest of the sponsoring group to now has been on dealing with the operational problems immediately at hand and not in marketing. That, however, may follow in due course.

Several British and overseas cab companies have contacted Computer Cab about their system, but till now none have followed up with firm orders. This is not to be considered as surprising under the circumstances since the company is not, as yet, attempting to market actively the system. Similarly, one local courier/ package delivery service has also enquired about using Computer Cab's technology but no firm order has materialized.

Despite the fact that only one site has been exploited, thus far, it is worth bearing in mind that Computer Cab is growing quite quickly. Within London, the service was initially marketed within the central city and in recent months has pushed strongly into the surroundings suburban areas. The company itself intends to market and extend the number of vehicles involved on a very active base.

4.3.3. Notable Features

In its first phase, Computer Cab offers no more or less than a basic computerized dispatching service with good security fand reference (i.e., billing) facilities. It uses or has:

- Standard Storno mobile radio

- Voice communications only

- Conventional dispatching technique - assisted by a host computer, a series of associated work stations, each with own VDU, and associated routines.

- No locational advice

- No fleet scheduling (drivers currently "flow with the work".)

- Late cabs "monitored" by receiving passenger complaints on computer.

Job scheduling: The system monitors incoming jobs and maintains all service requests on a hierarchical priority basis which is linked to (a) customer's known priority and (b) location of pick-up point.

Booking levels: All incoming orders and past performance are consistently monitored so that customers can be advised of realistic E.T.A. based on the position of the job in that "queue".

Control Room: The control room is manned by a total of 25 employees, 16 "order takers", 8 radio dispatchers and a supervisor. When the circuit is busy the 8 dispatchers are split on a "work and details" configuration, where the work is allocated on one channel but the full job details are given on separate channel. This is, in particular, a reflection of the considerable amount of information that needs to be exchanged on a high proportion of the Standing Accounts Trips.

A photograph of Computer Cab's control room appears below.

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Figure 4-5: COMPUTER CAB CONTROL ROOM

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Computer Cab currently uses a Honeywell DPS 6/76 computer purchased in 1981 for a number of administrative tasks, including the first phase of their TaxiCom projects. They are planning to upgrade shortly, and will have twin DPS 6/96 units by the end of 1985.

Similarly, the company uses a Plessey PABX telephone system, which is regarded as adequate if not ideal. They are currently looking into replacing this unit, but have yet to make a final decision in this respect.

In October 1984, Computer Cab began a search for new taxi meters, mobile radios, and other interface equipment which would permit the them to upgrade the efficiency of their system. In the coming months it will be interesting to follow their decisions and progress in this respect, to see what sort of technology and operations choices this obviously heads-up group decides to take.

Neither Honeywell, nor Plessey, nor any other of TaxiCom suppliers has thus far demonstrated an interest in developing its own TaxiCom variant and marketing it. Nor has Computer Cab itself emerged as an active marketer of its own system or expertise. Despite this last, however, Computer Cab is being regularly contacted for both information and eventual turnkey help, occasionally by taxi firms elsewhere in Britain, but more often from abroad.

Computer Cab reports that its system is "open-ended", that there is no upper limit on the number of vehicles handled, and that they are prepared to upgrade their system incrementally and in modules as technology advances permit. In fact they have just reported a purchase of 300 new radios and will begin installation immediately.

---------- For further information on Computer Cab, contact ----------

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Mr. Geoff Kaley
Managing Director

4.4. AP Radiotelefon

In Copenhagen, AP Radiotelefon A/S, an affiliate of the Philips electronics products group, has recently developed its own proprietary TaxiCom system under the name AP-Tax. The background to their system and its development path to this date is summarized below.

4.4.1. Background

"Increasing fuel and labour costs have meant a progressive challenge to all transport organizations, e.g. taxi companies, road delivery businesses and public transport. AP Radiotelefon A/S, a major supplier of land mobile two-way radio communications systems for the European market, in 1980 initiated a study programme together with some large Scandinavian taxi organizations with the goal to set the specifications for a computerized dispatching system.

This system should give information on the status and position of the cars in the fleet and thereby enable the control centre to direct the operation of each car more efficiently and economically. As the study proceeded, and increasing number of functions were added. A printer was placed in each car in order to minimize speech traffic on the radio channels thereby increasing the total channel capacity. A credit card reader was added in order to avoid the manual handling of credit rides, firstly by the driver filling in charge forms and next by the control centre. Recently the appearance of multi-function electronic taximeters has placed the device as a valuable, integrated part of the mobile equipment.

A further goal for the system designers was to create a highly modular system, both at the mobile and at the control center level.

This modularity ensures that small as well as large organizations can have the advantages of investing in an AP-TAX system. Furthermore a car fleet operator can start with a system containing only the basic functions and later on add more functions as his demands increase." *

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* Source: AP-TAX, October 1984

4.4.2. Present Status

AP Radiotelfon has recently begun to offer what appears to be among the most ambitious TaxiCom technology and operations packages that is currently on the market. A relative late-comer to the field, the firm already has one service (Oslo) gradually being brought into commercial operation, with a second in the full operations planning stage and due to come on line in Stavanger, Norway toward the middle of 1985.

The following table summarizes the extent of AP-Tax's deployment in the field as of early 1985.

Table 4-8: AP-TAX OPERATIONS SITES

City	Country	Date Service Initiated	No. Taxis
Oslo	Norway	Spring 1985	1375
Stavanger	Norway	Spring 1985	145

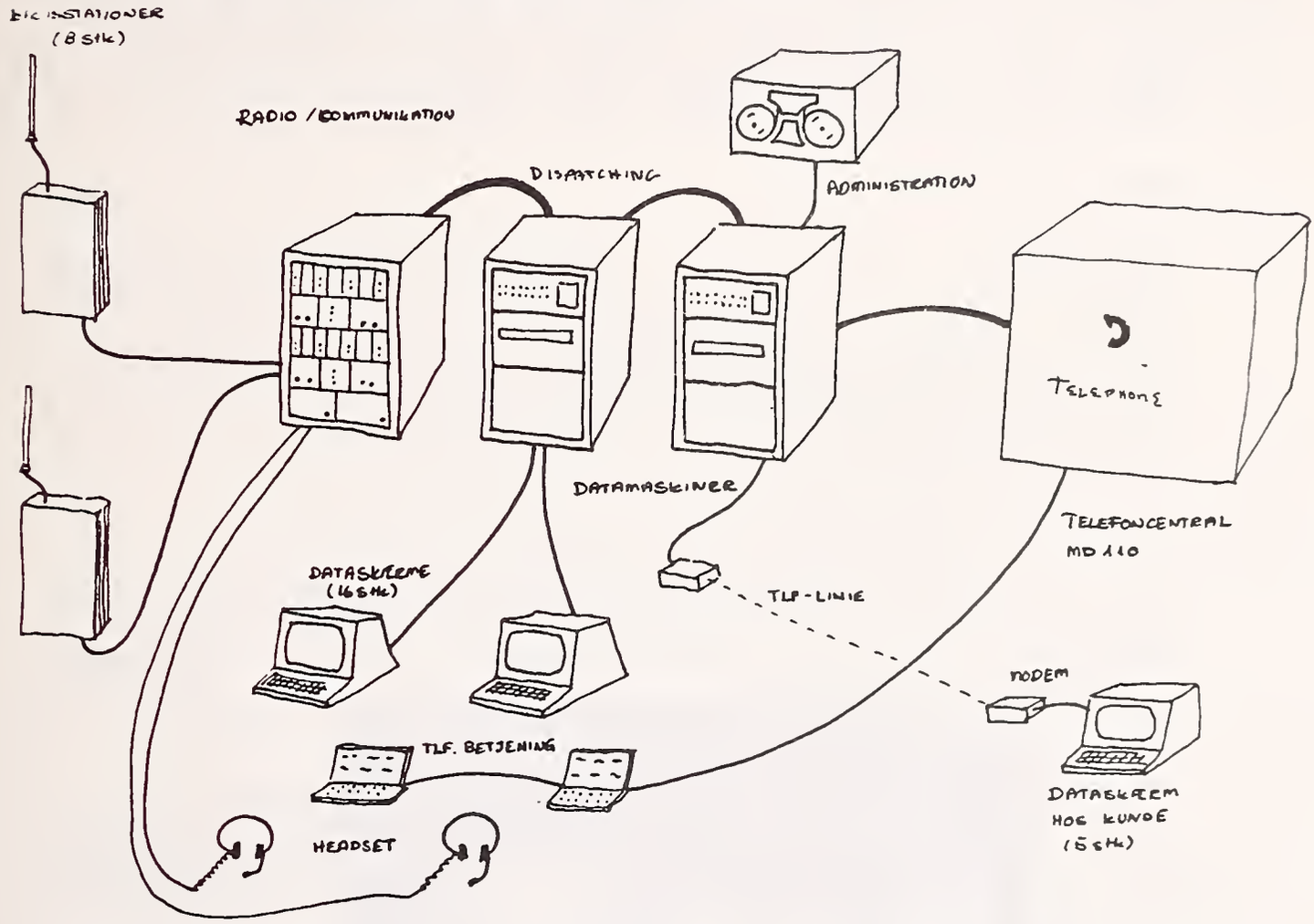
AP Radio regards these first two conversions as pilot projects for their new and as yet unproven technology package. Their goal, once these experiences have been fully absorbed, is "to have all aspects of the system worked out to the point where we can pack the whole thing in a box, take it to the studied site and set it up and put it to work without a hitch". To this end, they are marketing hard in Scandinavia , and, as well, have advanced contracts in Singapore and Sydney, Australia.

AP Radio is also searching for other markets or ways in which their technology could be employed. At present they are examining two other possibilities -- one involving oil distribution by tankers and the other a local delivery service. Both of these options are explored briefly in Chapter V below.

4.4.3. Notable Features

On the surface AP-Tax resembles Volvo's Taxi-80 systems in many ways, albeit with numerous differences at the level of the operating routines and the individual pieces of equipment used. The following diagram shows the AP-Tax control center layout, as well as the main pieces of equipment used in the control room.

Figure 4-6: AP-TAX CONTROL CENTER LAYOUT (OSLO)



The following paragraphs, edited from a company document, describe four pieces of equipment where the AP-Tax approach differs in substance.

Credit Card Reader

This unit reads all magnetically coded cards according to the ISO standard 3554 for track 2. With this facility installed the taxi organization can handle all of its own credit accounting for large customers and in addition offer the service of accepting all of the generally circulating credit cards like American Express, Diners Club, Visa, Master Charge, Eurocard, Access and others. By handling all data regarding a ride (card validation and debiting the fare to the customers' accounts) via direct radio contact to the control center computer, all paper work and thereby a substantial amount of manpower can be saved.

Backing Display

The display is placed in the wind-screen of the car and shows an alphanumeric, four character number (e.g. AB 73) -- the booking number assigned to the customer when the ride is ordered at the control center. The display makes it easy for the customer to find the car sent to pick him up, especially in situations where taxis come and go all the time, e.g. outside restaurants, hotels, transport terminals.

Taximeter

The taximeter used for the AP-TAX system is the Novax 85S, this a fully electronic, microprocessor controlled meter, offering a number of functions not normally found in taximeters. The number of tariffs has been extended to 6, of which 4 are divided into 9 sub-tariffs.

The meter can handle share riding, as well as a special kind of credit riding where each customer pays a fixed amount per ride in cash. This system operates in Norway where disabled people can use taxis against paying the normal bus fare. In this mode the taximeter can handle up to 16 passengers per ride.

This opens up a number of possibilities for the taxi organization to offer diversified services to the public, all of which can be handled within the tariff structure of the taximeter. Such services could include parcel service, limousine service, transport of disabled people and discount prices during less busy hours. Switching of the meter from day to night tariffs can be done automatically by the built-in calendar clock or by radio command from the control center.

Another feature is the possibility of reprogramming the meter via the radio. The possibility exists as all data subject to be changed are stored in an electrically erasable and programmable memory. This feature can save the cost of manual reprogramming.

System Interface Unit (SIU)

The SIU ties all peripherals together with the mobile radio and acts as the switching center for all information going to and from the car. It is a small box which can be placed away under the dashboard. As all other units are plugged into the SIU, they are easily exchanged for service.

Installation of On-Board Equipment

AP-TAX mobile equipment can be assembled to provide the exact combination corresponding with the expressed needs of a particular customer, in the most economic way. These units are as small as possible, given the fact that most modern cars only leave limited space for mounting in and around the dashboard. An example of the equipment mounted in a Volvo 240 is pictured below.

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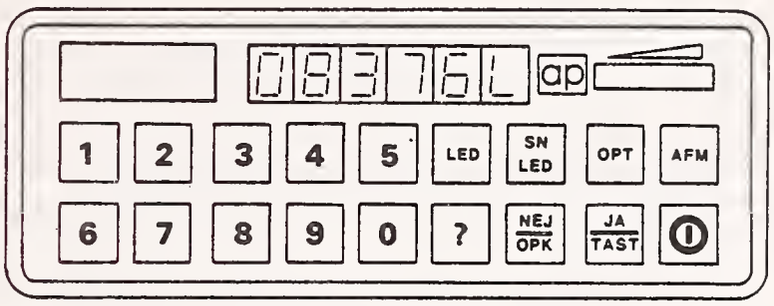
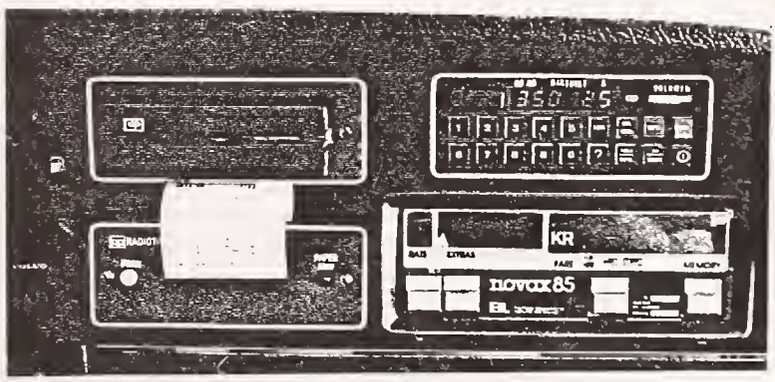
Figure 4-7: AP-TAX MOBILE CONSOLE



AP-TAX Mobile Control Head



AP-TAX Mobile Equipment
mounted in a Volvo 240

Source: AP Radio Telefon

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Another aspect of the system which is worth mentioning is the route planning system. Essentially, this is a ride sharing system in which overlapping routes are put together by computer for use in creating efficient routing plans for individual vehicles. This aspect of AP Tax had numerous other applications besides its use with passenger vehicles.

One wrinkle in the AP-Tax approach worth comment is the decision to include a credit card reader. And while this may in some sites be not particularly welcome to drivers, who may resent the intrusion in the preferred system of private accounts, perhaps the main technical problem it poses maybe that of radio band requirements as the credit card validity check and billing cycle is run. Of course, this is advertized by the purveyors as an optional part of the system which is perhaps best put off until such time that a basic entry level system is up and working.

AP-Tax has selected the Texas Instrument mini series 600 or 800 for this service. They recommend fully redundant, dual computer systems, one of which for on-line use and the other as a combination reserve plus administrative support device.

AP Radio Telefon is an affiliate of the Philips (Netherlands) electronics group. Till now, however, they have been left to develop this technology on their own. Interestingly enough, while Philips manufactures equipment that has considerable similarity with much of what the AP-Tax package offers, till now more of the parent company's components have been brought into the unit.

AP Radio warns that planners of these systems must take into account that the public may often be somewhat unrealistic in their early expectations as to what such systems can realistically accomplish. This is usually because media coverage tends to get out of hand. As a result, they have encountered numerous request for yet new services and features -- many of which may be attainable in due course, but which do not probably belong in an entry-level start up.

---------- For further information on AP-Tax, contact ----------

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Tel: (45/15) 477-777 Telex: 31172 APTELE DK

Mr. Moerk, General Manager
Mr. Benoch Nielsen, Project Manager

4.5. Taxi Telefooncentrale "T.T.C." N.V.

4.5.1. Background

The latest contender for the European TaxiCom market is a new group which is still in the process of forming up in the Netherlands. The chief movers behind this group are the Taxi Telefooncentrale "T.T.C." N.V. who are responsible for the of Rotterdam's 600-odd taxis, and their technical consultant, Ing. A. Breur who has been responsible for the development of this latest TaxiCom variant in Europe.

The system now being brought on line in Rotterdam started out initially as a Telco spin-off, under the name Taxi Telefooncentrale Automation System (TTC for short). The original idea as well as supplier was Telco, but over the four years of its development cycle the system has been wholely redesigned and tailored for Rotterdam, with a careful eye to the Dutch market as a whole. Today the suppliers include:

- Heinrich Pfitzner, for the mobile phones,
- Arsycom for software,
- DEC for computers,
- Telco for onboard microcomputer VDU unit, and
- TTC themselves for system design, software and management services.

TTC was first conceived in June 1980. Detailed operations planning began in May 1983. In the Autumn of 1984, the system first began to come on line with the first hundred vehicles up and working by end-year 1984. Vehicles are being added regularly until it becomes fully operational with 580 taxis to be in service on the official opening date on 4 April 1985.

Table 4-9: ROTTERDAM SYSTEM COSTS (1984)

	In Dutch Guilders	Approximate U.S. $ Equivalent *
Global System Cost	4,200,000 DG	$ 1,230,000
Mobile Equipment	3,100,000 DG	$ 910,000
Hardware, Software, Services	1,100,000 DG	$ 320,000
Radio Base Stations (five)	25,000 DG (each)	$ 7,300

* At exchange rate indicated in glossary

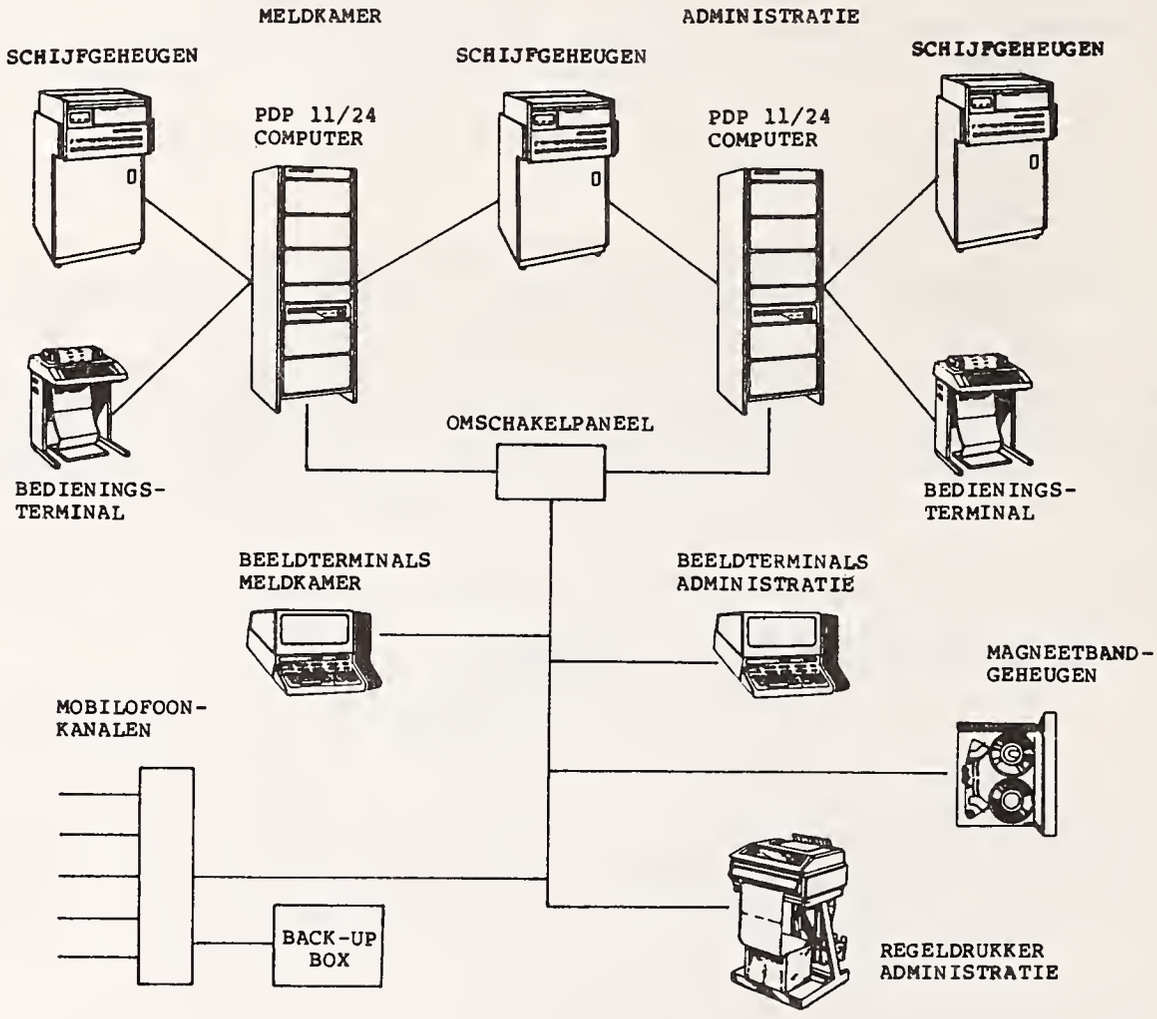
Subscription cost for taxi owners has increased slightly, from 190 DG to 240 DG per shift per month. The 50 DG supplement can be traced directly to the addition of the TTC central, for the normal fee across Holland for dispatching services is 190 DG.

Along with these monthly fees, each taxi owner must pay a total of 5500 DG ($1,600) for the new system. This price includes the cost of the mobile equipment and well as a small portion of the overall central cost. Financing arrangements have allowed this payment to be spread over a five year period.

The Rotterdam site employs two DEC PDP 11-24 computers, which are both supplied with all the data necessary for running the system. In normal operation the primary computer handles all real time requirements including dispatching, while the backup computer handles billing and related administrative functions. Both hardware and software are ready to expand to 1000 vehicles should a demand increase warrant such a step.

The following diagram shows how these two computers are connected to the rest of equipment in central.

Figure 4-8: TTC CONTROL CENTER (ROTTERDAM)



Rotterdam reports that they aim to save up to 40% in personnel costs in central.

Figure 4-9: TTC OPERATORS AT CENTRAL: PRIOR TO CONVERSIONS

4.5.2. Present Status

Over the last two years, TTC has taken the Telco system and significantly modified it for the city of Rotterdam (Netherlands).

The following table summarizes the TTC deployment situation as of this date.

Table 4-10: TTC OPERATIONS SITES

City	Date Service Initiated	No. Taxis
Rotterdam (TTC)	1985	580

At present five other cities in the Netherlands are reported as being "in of advanced negotiations" for TTC purchase. In addition, another 35 Dutch cities have expressed interest and are "waiting to see how the Rotterdam project works out".

There is as yet no marketing push outside of Benelux and it is the expressed desire of the TTC sponsors to avoid such activities until their technology and operations package has a firm track record in Rotterdam.

4.5.3. Notable Features

The TTC system can be described as a "full-function TaxiCom", much as described in the Taxi-80 and AP-Tax profiles. It includes the usual dispatching algorithms, geofile (i.e., address register and verifier) and a billing subprogram (for standing accounts).

TTC-Taxi also permits the customer to specify in detail the type of vehicle he requires. Advanced ordering can be handled for "years in advanced". Once an order is specified, it will be guaranteed until cancelled!

The TTC system also provides for group riding. It not only handles the best routing for such rides, but also figures out the charges for each group member as well as handling all billing. The algorithm, which has been developed by the Breur Group, is also capable of identifying both group membership and routing and billing where there is a change.

---------- For further information on TTC, contact ----------

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Mr. Van Hoorn
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Dip. Ing. A. Breur
President

---

5. THE RESULTS

The following chapter overviews the main results achieved by these technologies and service approaches in the field to date. The results can be broadly classified in five separate areas:

- Service Improvements;
- System Improvements;
- Work Condition Improvements;
- Costs and Economics;
- Planned Extensions.

In most cases, we have not attempted to cite the detailed results of the individual projects but rather have tried to provide a general overview of what the better systems appear to be able to achieve in their actual commercial contexts. That, after all, is the real bottom line for those interested in understanding how these techniques can be put to work for them in their communities.

5.1. Service Improvements

The area of most significant improvement as far as the general public is concerned is the service rendered to customers. The net result of the project experience reported here is that TaxiCom is showing that it can deliver faster, more reliable, and more efficient taxi service both to the general public and for the elderly and handicapped. This can be discerned from a number of indicators.

5.1.1. Speed of Order Taking/Processing

In virtually all the sites surveyed, TaxiCom has substantially increased the dispatching centers' ability to handle orders. To the customer this increased efficiency means that he should not get a busy signal or have to wait for a free line, as one (fast) call is nearly always sufficient for placing an order. The main reasons for this improvement are summarized below:

- TaxiCom generates, as part of its normal operations, the planning information needed to ensure that adequate dispatching personnel will be on hand depending on the time of the day and other similar variables.

- TaxiCom has shown that it can offer efficiency advantages at both the "order taking" stage (i.e., the time needed to obtain from the caller all needed information) and the "order handling" stage (i.e., the time needed to process the order and confirm both with driver and client).

- Order taking appears to be slightly improved, primarily as a result of the better "preparation" of the caller who is able to initiate the order in almost all cases with no initial wait. (This improvement is, however, quite slight to date and nobody as yet appears to have tried to quantify it.)

- Similarly, the "neatness" and standardization of the operator prompts the user to ensure that he supplies the needed order information quickly and in the right order.

As a result of these improvements, the order handling process is much improved, with the average customer needing to spend only about 10 to 15 seconds on the phone to place his order and receive confirmation. This is a considerable improvement over the one minute or more (the general average being around one and up to three minutes) dispatchers usually require to contact the driver and confirm.

Through digital transmission the computer is able to locate and notify the selected taxi of an order roughly ten times faster than through traditional radio communication. Users notice this improvement since they are informed literally within seconds of the pick-up time -- as opposed to the painful waits needed while a radio operator manually interrogates the entire fleet before finally negotiating the order with the "best placed" taxi.

It is necessary to qualify the above, however, by the following proviso. Brute speed of order taking is not in itself an adequate judge of TaxiCom performance. Some operators may wish to develop a more extensive set of information from each ordering client. In such cases, quite naturally, the order taking process will be just that much more cumbersome and time consuming.

5.1.2. Speed of Pick-up

The net reading of the results obtained to date is that, in first stage TaxiCom conversions at least, the time needed on average for pick-up once the order has been confirmed is not greatly reduced. This should not be surprising though, when one considers that virtually all these systems take aim at this particular problem not as a first stage target but only once they get a bit beyond the initial run-in period.

Two mechanisms are potentially available to deal with this particular operational problem in due course:

- The "Fleet Management Function", and the extent to which the dispatcher is able to improve the mesh of supply and demand as far as ensuring that the right number of taxis is in service at any point in time.

- The "Recommendation Function", which allows taxis to be placed nearer to where they will eventually be wanted.

Neither of these are usually programmed to come into service until the basic entry system has been fully operational for some time.

What appears to be happening in most cases is that, more or less in lock step with service improvements generated by the new systems, which are quickly picked up by taxi users, the demand for taxi services is gradually increasing. And since most communities tend to regard themselves as having too many taxis (this, of course not necessarily, being the view of the travelling public), there is invariably no expansion of the number of taxis on the road and, hence, growing pressure on the supply side. Fortunately, the technical advantages of most TaxiComs even in their first, simpler alpha configurations appear to be working to keep this aspect of their service from deteriorating too markedly.

5.1.3. Improved Reliability of Service

The surveyed systems all (except Computer Cab which has not yet reached this stage) appear to be improving service reliability in a number of ways:

- Computer control of data base, ensures no filing errors;

- Computer checks accuracy of all addresses against own files, thus avoiding dispatching orders to non-existent streets or numbers;

- Permanent checking (polling) of all unfulfilled stored and dispatched orders until completion.

Some systems also permit reliability checks to seek out both non-performing drivers and to identify individuals who are not reliable customers (no-shows, habitual lateness, payment problems). Virtually all could, in due course, add such services, at low cost.

5.1.4. Advanced Reservation Capacity

The reviewed projects appear to be achieving more efficient and -- what is no less important -- more extensive reservation services. (This includes both one-time advanced reservations and long term standing orders.) Additional advantages include:

- More convenient advance ordering;

- Guaranteed service for: Advanced Reservations and Standing Accounts;

- The virtual elimination of lost orders, since problems of overlooking orders due to changing shifts and other human errors seem to be being brought under control with computer filed orders. (The computer carries out a continued polling of all un-filled orders, and thus is able to guarantee that even last minute oversights will be subject to control and correction.)

5.1.5. Established Payment Facilities

Various TaxiCom installations are either clearly planning or looking into the following payment conveniences:

- Automatic credit card billing;

- Automatic debiting of Standing Accounts;

- Automatic debiting of state agencies offering various "user-side subsidies" including for E & H and other aided groups).

At present none of the existing installations are as yet at this stage of sophistication for all of these services. However, it is a planned up-grade in virtually all of the projects.

Incidentally, one clear advantage of TaxiCom to owners is that they are thus much better able to prevent driver fraud on reported revenue.

5.1.6. Elderly and Handicapped Benefits

There is one important user group that is already benefitting from TaxiCom improvements in a number of ways in the Swedish and Norwegian projects -- the elderly and handicapped. It should be recalled that close to half of all taxi business in Sweden currently derives from these subsidized customers. Since they are important users, and further since many of them have rather special transport requirements (wheel chairs, may need driver help to access, exit, etc.), the ability of TaxiCom both to: (a) spot these special requirements, and (b) service them efficiently, is important.

Similarly, the elderly and handicapped may also often encounter difficulty in dealing with telephone operators at the time of ordering. Since (a) TaxiCom operators are less hassled -- therefore apt to be kinder; since (b) the computer can help the operator to recognize quickly the caller (e.g., filling in on partial or partly wrong addresses and other helpful stored data recall and cross-checking), the human interface of TaxiCom with these special users can be a lot more friendly. (Further information on TaxiCom's potential for transport of the elderly and handicapped will be found at the and of this chapter.)

5.2. System Improvements

Among the most striking features of TaxiCom is its potential to achieve marked increases in capacity and performance at the level of the complete system.

5.2.1. Dispatching Capacity Improvements

Aided by the computerized system, the dispatchers in the control centers are able accommodate at least twice as many customers as they were able to prior to TaxiCom. Some claim up to four times more orders per control room personnel. This results in a considerable decrease in the personnel requirements for the control room or, more positively, for a substantial expansion of system capacity without increasing labor costs of this part of the operation.

5.2.2. Ridership Increases

On the strength of the evidence, we believe that TaxiCom should in due course lead to increased use of taxis -- i.e., more as well as better service to the traveling public. As taxi use becomes more convenient and more reliable, as the environment inside the taxi and relations with both the driver and dispatching office become smoother and more pleasant, it would seem inevitable that ridership will increase.

Most of the project managers contacted, however, do not appear to be particularly optimistic about what can be achieved in terms of eventual large scale increases in demand. Perhaps they are too close to the operating side of their business and too accustomed to the many years of economic downslide that most in the trade have suffered from. Our own independent but not statistically supported impression is that these systems are indeed going to generate **much** larger than anticipated increases in demand -- on the assumption that they are planned and implemented correctly. Positive feedback on this will, however, have to await a bit more experience with these systems.

Moreover, once service economics have been improved -- and particularly in the event that ride sharing becomes a reality -- taxi rates should be able to be reduced. At this point, we can anticipate substantial growth in ridership -- which will, as well, allow new classes of rides to begin to make major use of these important public carriers. <<See below on revenue impacts.>>

5.2.3. Reduction in Deadheading and Cruising

A taxi's least cost-efficient activity is to be driving without the meter running. This can be either as a result of cruising (looking for a fare) or deadheading (moving without being paid to pick up an order). Any technology or operations technique that can reduce these empty runs is going to save on vehicle running costs and gasoline, even if it were not otherwise able to put passengers into the car. The advantage of TaxiCom is, of course, that it manages to do both.

Consistent information on this particular topic has been difficult to generate. That said, virtually all projects appear to have achieved tangible improvements here -- and if we were pressed to provide a figure representative of the order of magnitude of these improvements, we would suggest something on the order of 10-20%.

In Gothenburg, to look at but one concrete example, taxis used to log an average of 90kms per day of moving without a fare. Taxi-80 has reduced this to 30kms per day. And as the system becomes more finely tuned to a city's particular needs, this figure can be expected to drop even further.

5.2.4. Fleet Scheduling Improvements

TaxiCom's potential for ensuring a better match between the number of taxis on the road and specific demand under the circumstances, is considered as among its most important attributes for both owners and drivers. No concrete results were available on this to date, though a pulling of the leading Scandinavian sites in mid-1985 should generate some interesting results in this respect.

In point of fact, however, it will be in this area where it may prove most difficult in many communities to profit from these potential advantages. Where taxi ownership is widely spread out, unless there is a sufficient form of organization, such as a cooperative agency, there will be no means for deciding who will drive when. Unless a means exists for controlling the number of vehicles on the road, this very valuable asset will not be able to be exploited.

5.3. Work Condition Improvements

One of the not-trivial benefits of an innovation of this sort is that it provides the employer and those concerned with an opportunity to re-think and to re-structure the working environments of those involved. The fact is that change over to a computer-based environment is, of itself, no guarantee of work conditions improvement. To the contrary, the business sociologist can find many examples of thoughtless computer conversion where working conditions have actually gotten worse.

Thus, there is a balance to be struck. TaxiCom can provide an opportunity to improve these conditions. However, those concerned must also recognize that computers and their accompanying systems can be a source of stress. Eye strain, psychic stress, backache, radiation... are real potential dangers which need to be coped with in advance.

In the case of the TaxiCom installations under study here, the rise in the quality of service has apparently been accompanied by improvements in the working environment of virtually all those concerned.

5.3.1. Dispatcher/Control Center Personnel

Transforming the job of a telephone operator or dispatcher to that of a computer operator-cum-receptionist, TaxiCom has created a job which, by comparison with what went before, is calm and relaxed. Freed from the harried atmosphere of a dispatcher who has to scramble in his never-ending search for taxis and free radio channels, the operator is able to handle calls quickly and pleasantly.

These advantages have been achieved because of (a) the ability of the system's managers to achieve a better daily and hourly balance between customer demands and central's order taking capacities; (b) the inherent ability of each operator to handle many more calls with greater efficiency; and (c) the innate capacity of the system to "stretch" to accommodate short-term fluctuations in demand within set staffing levels.

Volvo has also concluded that the more friendly reception now available when ordering a taxi is one component of the increased demand that has been encountered in several of their sites.

5.3.2. Drivers

TaxiCom has created a more pleasant atmosphere within the taxi itself, as well as a more efficient one.

The absence of continuous radio presence and cumbersome voice communication routines appears to relieve a considerable amount of unnecessary tension and stress. This not only enables the driver to concentrate more fully on driving, but also allows for more personal contact between the driver and the client. Though an often overlooked amenity, this can result in increased satisfaction from both parties.

Furthermore, the system inhibits the often nasty competition among drivers for customers, and charges of bribery and individual driver favoring which are the common gossip of most conventional radio dispatching services.

Finally, with the growing concern for safety in urban and other settings, it is worth emphasizing that driver security has been significantly enhanced with the monitoring device that can be activated by the emergency button.

Incidentally, organizations should be prepared for a negative reaction from a fairly high proportion of all drivers (say 10-25%), whether working conditions are improved or not. This is because certain types of personalities inevitably perceive all changes as negative. (Just as some tend to view initially all change as favorable, no matter what the reality is.)

For the record, the usual pattern is: 20% knee-jerk positive; 60% wait and see; 20% knee-jerk negative. Thus, what you have to deal with in any technology or management conversion is: (a) to get that first group on board immediately, but without overselling (since some of these can backfire quickly); (b) ensure that the 60% "silent majority" is brought in as quickly as possible by the results; and, then, (c) to begin to chip away at the negative group by a variety of strategies.

As to the trade-offs as far as the printer vs. visual display unit is concerned, we are not yet able to judge which is the preferred option. In any event, we urge readers interested in such an application to look into both options.

5.4. Costs and Economic Improvements

5.4.1. Caveat on Cost Data

Readers will do well to use both their imagination and considerable care in interpreting the exact significance of the price information that is reported in the various profiles. The cost figures cited record what was paid at the time of purchase for that particular transaction, and these necessarily vary.

For starters, price differences among the varying technologies should not be compared directly, as each system differs in what it is attempting to provide in terms of service and technology and sophistication. The actual costs incurred by any given project is in many ways unique, and hence difficult to use for direct comparison.

Second, the taxi operation that is merely enhancing its traditional dispatching system with TaxiCom rather that starting from scratch will doubtless be able to forego certain start-up costs, especially if they have appropriate computers, dispatching facilities, radios, taxi meters, etc., already in hand.

Third, larger systems can, or at least should, benefit from economies of scale.

Fourth, there will in many cases be significant cost differences from country to country -- with Europe, in most cases, likely to be a higher cost environment that what one is likely to encounter in North America.

Fifth, it is important to bear in mind that local environmental considerations are likely to influence costs considerably. This includes not only the size and topography of the service area but also -- very importantly -- the situation with respect to radio frequency availability.

Sixth, there is the matter of price changes over time. Microprocessor-based technology in particular is advancing so rapidly and their costs dropping so radically that certain of these historic figures quickly lose their meaning. (Fortunately, in this case at least, the nature of these price changes is steadily in favor of these projects.) That said, we have in each case attempted to identify the year of the purchase in question, which will allow the informal reader to extrapolate intelligently, especially as he makes it a point to improve his information on current technologies and price offerings in the field.

Seventh, there are the problems of direct cost comparisons among different currencies, whose relative values have been skewing widely in recent years.

Eighth, there is the amount of consulting services required, which relates to the how much the individual taxi company wants to get involved in the planning and implementation of the system. Certainly a company which wants to be handed as a fully operational system will be paying more than one which actively contributes to the overall planning and implementation process.

Finally, average cost figures per vehicle are going to be heavily influenced by the individual financial arrangements, that vary greatly form project to project.

All of the preceding does not, of course, rate out the possibility of price comparisons. It should however make the reader be a bit careful both in engaging too recklessly in such comparisons, and even a bit critical concerning whatever we might wish to advance on the subject.

Readers have already been warned about the rough and ready nature of much of the cost data. That appears in this report, and of the dangers of direct and too simple comparisons between very different projects and technologies. That said, we do (a) have a certain number of cost figures which have been developed over the course of the survey, and (b) some readers who will wish at least to be brought into the ballpark on some of the more critical cost issues. Therefore, with this caveat, we have decided to plunge into the data that we have at hand to see what if anything the figures tell us about what we need to know.

5.4.2. Cost Considerations

Enough is now known about Taxicom in actual operation that there is no reason that the planner should not be able to cost out a given project with confidence, if not to the last dollar at least in terms of the broad magnitudes of costs that are involved in bringing such projects on line.

The following table provides a first summary of the costs incurred in the thirteen demonstrations that have taken place to date. These costs have in each instance been reported in local currencies and have been converted to US dollar values using the exchange rate prevailing as of 20 October 1984.

Table 5-1: TAXICOM ATTRIBUTES - INTERNATIONAL OVERVIEW

Project Site	System	Country	Year Init'd	No. Taxis	Total System Cost (US $)	Cost/Vehicle All	Cost/Vehicle On-Board Equip.
Gothenburg	Taxi-80	Sweden	1982	615	$1,506,373	$2,449	$1,281
Malmo	Taxi-80	Sweden	1982	210	$1,042,874	$4,966	$2,317
Stockholm	Taxi-80	Sweden	1983	1725	$7,762,500*	$4,500*	$2,317
Linkoping	Taxi-80	Sweden	1984	77	$451,912	$5,869	$2,649
Boras	Taxi-80	Sweden	1983	62	$289,687	$4,672	$2,430
Baerum	Taxi-80	Sweden	1984	225	$1,022,727	$4,545	$2,939
Trondheim	Taxi-80	Norway	1983	189	$454,545	$2,405	$1,563
Bergen	Taxi-80	Norway	1985	310	$1,254,545	$4,047	$1,870
Oslo	AP Tax	Norway	1985	1375	$4,318,182	$3,140	$2,066
Stavanger	AP Tax	Norway	1985	145	$1,022,727	$7,053	$2,614
Zurich	Telco	Switz.	1980	400	$1,209,677	$3,024	$2,117
Rotterdam	TTC	Neth.s	1985	580	$1,231,672	$2,124	$1,567
London	Comp.Cab	U.K.	1983	1630			$683
Average				580	$1,797,285	$4,066	$2,032

* Stockholm total system cost cited by VTS at SKr. 25 million - We have substituted above figure after our analysis of detailed project data.

As will be noted there are elements of the above table that are as yet incomplete and in two cases we have gone so far as to insert our estimates of important values. What is perhaps most important in all of this is the two bottom line figures: i.e., that if you are planning to try for a state of the arts TaxiCom, you should be prepared to pay up to $5,000.00 per vehicle for all project costs, with roughly half of that being for on-board equipment -- i.e., the costs that in most projects will fall directly to the taxi owner/operators.

This is not to say that investment expenses must be as high as this -- since there are any of a number of ways that are available for reducing these expenditures -- but rather that is the trend for what has gone on in Europe thus far.

A breakdown of the above by type of system is provided in the following:

Table 5-2: AVERAGE SYSTEM COSTS - BY MAIN SUPPLIER GROUP

System	Year Init'd	No. Taxis	Total System Cost (US $)	Cost/Vehicle All	Cost/Vehicle On-Board Equip.
All Taxi-80	1983	427	$1,723,146	$4,182	$2,171
All AP-Tax	1985	760	$2,670,455	$5,097	$2,340
Telco	1981	400	$1,209,677	$3,024	$2,117
TTC	1985	580	$1,231,672	$2,124	$1,570
Comp.Cab	1984	1630			$683
Average		580	$1,797,285	$4,066	$2,032

(For the record, since there has been considerable unstability of exchange rates over this period, we have also run through the local currency figures using exchange rates appropriate to the period when the investment was actually made. The next impact of this drill is to increase the global averages by about 10%. As against that, we also know however that technological process is rapidly driving these costs down, so we see little reason for further modifying the above.)

5.4.3. Software and Project Management Costs

In order to achieve a moderately advanced TaxiCom service package, it is going to be necessary to put money into software. At present these costs are still high, and considering groups should be prepared to spend anywhere from $100.000 to $300.000 for a full set of software support.

As the market expands in the future, these costs are likely to come down considerably -- although a considerable amount of work will be required in any event in virtually all cases for software customization to be sure that that system is carefully attuned to the community and operating groups in question.

A second cost component that is perhaps less likely to recede so quickly is the cost of project management. Among the main tasks that this covers are:

- System Definition
- Licensing
- Coordination
- System Integration
- Equipment Installation
- Training
- Acceptance Testing
- Debugging
- Turnover.

These costs vary with reference both to the size of the system and its complexity. In most cases a fee of $300 to $500 per vehicle appears to be appropriate.

5.4.4. Paying For TaxiCom

At $5,000.00 per vehicle, all in, a medium sized community or cab company with a few hundred vehicles is going to have to come up with somewhere around a million dollars in order to convert to TaxiCom. Without wishing to worry now about whether or not this is ultimately going to require either more or less than that (though we guess rather less), it nonetheless is interesting to examine the results of the projects to determine just how much of a burden this is likely to create in a practical business sense.

Table 5-3: TAXICOM COST AND PAYBACK - OVERVIEW
(In US $ at 20/10/84 Exchange Rates)

Project Site	System	Total System Cost (US $)	Monthly Sub'n	Sub'n Inc. in 12 Months	% Total Cost Paid By 1 Yr. Sub'ns
Gothenburg	Taxi-80	$1,506,373	$156	$1,154,461	77%
Malmo	Taxi-80	$1,042,874	$295	$744,612	71%
Stockholm	Taxi-80	$7,762,500 *	$145	$3,005,458	39%
Linkoping	Taxi-80	$451,912	$307	$283,731	63%
Boras	Taxi-80	$289,687	$417	$310,359	107%
Baerum	Taxi-80	$1,022,727	$210	$567,614	55%
Trondheim	Taxi-80	$454,545	$182	$412,364	91%
Bergen	Taxi-80	$1,254,545	$183	$680,591	54%
Oslo	AP Tax	$4,318,182	$73	$1,200,000	28%
Stavanger	AP Tax	$1,022,727	$216	$375,682	37%
Zurich	Telco	$1,209,677	$190	$912,000	75%
Rotterdam	TTC	$1,231,672	$70	$487,200	40%
London	Comp.Cab		$54	$1,049,561	
Average		$1,797,285	$192	$860,279	61%
	All Taxi-80	$1,723,146	$237	$894,899	70%
	All AP-Tax	$2,670,455	$144	$787,841	32%
	Telco	$1,209,667	$190	$912,000	75%
	TTC	$1,231,672	$70	$487,200	40%
	Comp.Cab				
Average		$1,797,285	$192	$860,279	61%

Specifically, the above attempts to take a look at the relationship between the investment required for TaxiCom conversion and the monthly fees currently being charged to taxi drivers to participate in the various schemes. In this respect, we can note:

- That the monthly fees for TaxiCom (column 4) run close to twice the level that currently apply in most of Europe for conventional radio dispatching services.

- That several of the fees cited actually include financial charges for full conversion and others just for the extra costs incurred at Central.

- Col. 5 shows the total fees paid in for all taxis in the given system over a full year.

- Col. 6 shows the proportion of total conversion costs that would be covered by a single year's subscription payments.

- Col. 7 shows the proportion of the costs incurred for Central (i.e., ex. all mobile equipment) that would be covered by the total paid-in subscriptions in a single year.

Without worrying overly about the niceties of the above calculations, this suggests that from the vantage of the subscription fee component alone these projects should not have undue difficulty in paying for themselves of course that subscription income will in fact be needed for other (operating) costs as well, but, still, exercise does seem to indicate that the necessary scale of resources appears to be there.

5.5. Future Prospects

What we are seeing today with today's first generation TaxiCom systems is not just a minor upgrading of a minor element of the public transport sector (itself in decline?) but, quite possibly, the beginning of a major re-structuring of this part of the public transport capacities of our cities. We arrive at this view because it can be clearly seen that:

* Taxis are not a trivial transport provider -- after all they carry several billion passengers in the United States each year, more than 70% of the total of urban passengers;

* Their operations are subject to enormous, near-term improvements;

* Some of these improvements -- including those of the TaxiCom variety -- may well spill over into the broader transit picture with even greater impact and potential for improvement.

* Finally, it has been established that taxis are important service providers for the "transport disadvantaged", the elderly, handicapped people, non-drivers and , surprising but true, many poor people who cannot afford to own a and operate their own cars.

Specifically we can anticipate on the basis of what we have seen with the surveyed projects, at least two main kinds of extensions:

- First, and in the immediate future, more systems of the sort described in these pages.

- And then, shortly, more diversified and more powerful systems along the lines indicated below.

In the first case, we at EcoPlan now anticipate a growing wave of conversions to this new technology. The first dozen projects are fast proving their point. Thus, we foresee that within the next few years literally hundreds of communities across Europe and North America will begin to give serious attention to these systems and yet additional variants.

Above and beyond this there can also be expected to occur a certain number of "changes in kind". The TaxiCom implementations of 1985, 1986 and beyond are increasingly going to venture beyond the familiar waters of today's first generation systems, and shall begin to look for and provide new types of services.

Two of these service extensions are worthy of further attention to the extent that they related particularly to the paratransit aspects of these services. One -- the systematic extension of TaxiCom as a major purveyor of service to the elderly and handicapped -- is already well underway. A second -- i.e., the capacity to transport groups of unrelated people -- is not only likely to occur but has the potential of making some important contributions to the larger public transport scene.

5.5.1. Transportation of the Elderly and Handicapped

TaxiCom is well adapted to the special transport problems of many elderly and handicapped people. A properly planned system can, for example, offer:

- Full door to door service;

- Easier and more accurate ordering and dispatching (through such means as computer's capacity to maintain each client's file with address information, including the person's eventual special requirements, and its ability to cross-check these details automatically at the time of ordering);

- Ability to ensure that vehicle selected is appropriate to client's special needs (e.g., wheel chair capacity);

- Driver selection among those willing to provide special personal services (e.g., help to door, giving a hand with a wheel chair, guiding a blind person those extra few steps), with clear indication of needed support tasks, allowance for additional time needed, and eventual billing adjustments;

- Flexible fare and billing arrangements, including direct billing of social service agencies, etc.

These advantages exist not only in theory but in actual fact and are actively being demonstrated by the systems which have thus for been put in place. Quite advanced versions of these can be found today in virtually all of the nine Swedish and Norwegian projects -- and full information on how these work can be gleaned from the sources indicated in Annex A below.

5.5.2. Ridesharing as an Option

The computerized aspect of TaxiCom makes it well suited for incorporating "ridesharing" into the traditional form of taxi service. The existing software can be programed to incorporate this new function and the in-place hardware not need to be changed. (The one exception to the last could be a purpose-built taximeter for these purposes.)

Ridesharing under TaxiCom could function in the following manner.

1) At the time of order taking the dispatcher will either: (a) enquire if ordering party wishes a shared ride option, or (b) immediately call up the passengers personal "dossier" (split screen) which will already have this information on record.

2) The computer then runs not one but two sets of checks, i.e., to identify both exclusive and shared ride options. It identifies both on CRT, with differences in eventual waiting and travel time and fare also displayed.

3) The dispatcher offers both options to caller, who then selects. (This, of course, will not be necessary where user's dossier shows strict preference for one or the other form of service.)

4) Upon notification of preferred option, TaxiCom then processes request as usual.

Note:

a) The above will be substantially easier to implement -- at first at least -- for standing transport orders.

b) The computer can itself be instructed to poll periodically all standing reservations to identify possible matches.

c) TaxiCom could automatically generate a letter to such clients to inform them of the option and its costs and other differences, telling them to contact the dispatcher if agreed, so that a standing order for shared service can be entered into the computer.

Approached correctly, ridesharing along these lines could have a number of advantages. First, it could reduce the amount that an individual passenger would have to pay for a taxi. Secondly, it increases overall transport systems capacity, for more taxis are now available to the general public. And finally, both the owners drivers earnings can be increased since the sum of the fares of a shared ride are greater than a single fare would be.

To the extent that ridesharing is offered as a subsidized service, the workings of a good TaxiCom could be configured to help in lightening the booking effort that is needed in such cases. A properly defined system could cut down on operating costs, speed up payments, and reduce both fraud and errors.

In most communities there will be many barriers and considerable resistance to ride sharing. Most of these are more apparent than real, but all are firmly believed by at least someone and hence need to be dealt with.

In any event the ride sharing option -- like TaxiCom itself -- has a heavy institutional interface, and these problems of resistance and the various other barriers are going to have to be addressed from the outset. Fortunately ride sharing does not have to be the <u>first</u> step in such a program, and by the time it becomes a serious option, TaxiCom should already have established extensive and impressive track-record which will certainly facilitate such an extension.

5.5.3. Planned Extensions of Existing Projects

Virtually all of the TaxiCom projects and technology development efforts surveyed to date are currently undergoing phased development and extension.

VTS, Ericsson and Telco are all seeking further extensions and improvements of their offerings, and are actively marketing them as turnkey packages. Computer Cab, on the other hand, already has a phased implementation program in which step by step they will continue to extend their system.

Among the extension options currently being considered for the various projects, we would note the following:

5.5.3.1. Large Customer Direct Orders

As previously demonstrated, the method for obtaining a taxi through TaxiCom involves the individual customer calling the control center and placing an order. In a effort to increase efficiency, both Telco and Taxi-80 are considering eliminating this step in certain cases.

Specifically, they are making provision for large customers to be supplied with their own terminals, which can be connected directly to the central computer. These clients key into the computer the appropriate order information much in the same way the operator does now. A taxi could, therefore, be ordered directly, and phone contact with central could be bypassed altogether.

The first such system is now up and working in Trondheim (Taxi-80).

Hospitals, schools, shopping centers, large employers, industrial parks and certain social facilities (sports) are likely candidates, as they are often constant users of taxis.

This same interface could be harnessed to create a link with various other forms of transportation. Airplanes, ships, ferries, and trains could all be equipped with a terminal that would allow advanced ordering so that their passengers could be picked up by a taxi when they arrive. Each would be specially programmed for circumstances unique to their needs. Thus, planes would be able to immediately postpone its orders should it be put into a last minute holding pattern above the airport. Likewise, ships, ferries, and trains would be able to adjust their orders to insure prompt connections.

5.5.3.2. Express Deliveries

A similar service for parcel deliveries has been examined by several of the sources and has the potential to be a very large market indeed. Companies requiring delivery services have begun to use taxi to transport their parcels.

If a company's requirements are large enough, they too could be supplied with a terminal that would be directly attached to the computer. This would not only save them the time of scheduling pickup through an additional overlay of equipment and people, but it would also save Central the expense of dealing with customers who could order their own taxis directly.

5.5.3.3. Oil Delivery Service

AP Radio is, at present, examining the possibility of employing the basic TaxiCom technology for an oil distribution service. The idea involves using their route planning system to create an efficient delivery schedule and a tanker delivering heating oil. This would reduce the number of "dry run" kilometers, which is analogous to deadheading, and would result in considerable savings.

5.5.4. BCI Centre - A Swedish Demonstration Project

Several Swedish organizations are already moving to take TaxiCom a very large step ahead, with their design of a global public-transport communications system interface which extends to include, in addition to taxis, all forms of public transit for the city of Boras, Sweden. They are calling this project the "BCI Centre".

The objective is to build up and evaluate a system for the organization and planning of all types of public transport within the region. An essential part of the system is the so-called "BCI-centre", that is a centre for Booking, Control and Information. The immediate objective is to evaluate at full scale the extent to which improved coordination in organization and planning can lead to a more efficient utilization of resources from the view-point of the various transport providers involved, their passengers and the society as a whole.

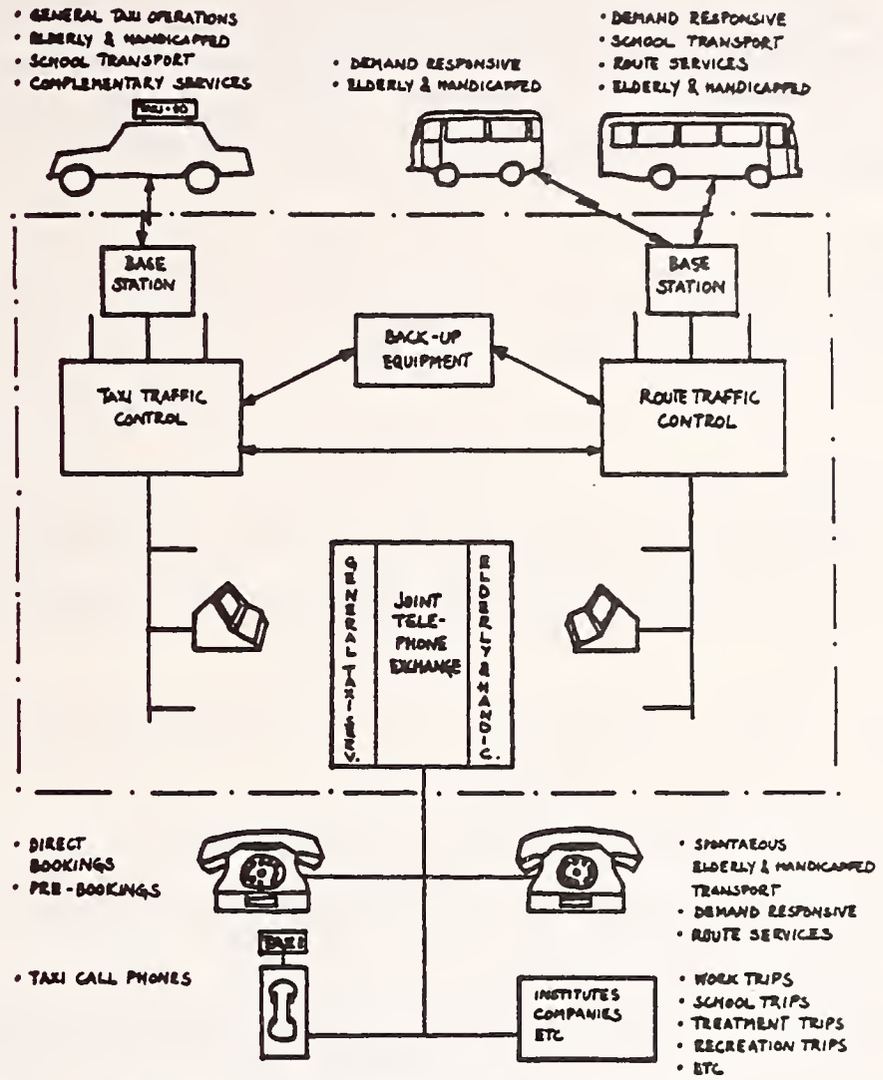
The following parties are involved in the project:

- The Swedish National Public Transport Committee (KTB)
- Boras Transit Authority (BT)
- Boras Taxi (BTA) and other taxi associates in the region
- Volvo Transportation Systems Corporation

Before the project, the Boras Transit Authority and the Taxi Association operated from different headquarters using separate telephone exchanges, radio systems and office computers for their administrative routines.

With their joint BCI-centre, one common system can handle all administration, planning, management and follow-up tasks. This co-operative utilization of resources is, in Boras, being extended to not only equipment and buildings but also personnel and vehicles.

Figure 5-1: HOW BCI WORKS



BCI-centre (Booking, Control and Information centre)

Work on the BCI project was initiated in August 1980. It is estimated that it will be ready for use in 1985. Results of the initiated pilot operations are still being gathered and analyzed as of this date.

Summary of Objectives

The system implies a number of benefits and the opportunity of coordination. The BCI-centre can:

- provide information concerning routes, services, and departures to the general public via the telephone network;

- handle demand-responsive traffic both for elderly and handicapped and general services;

- long-term plan efficiently and quickly alter schedules for school and commuting transport;
- make possible a zone-based fares system for taxi journeys paid for by municipalities;

- significantly simplify invoicing routines between taxi and local agencies;

- provide more efficient utilization of the vehicles;

- provide a single booking centre for all public transport within the region, including taxi journeys;

- coordinate rides/trips paid for by the municipalities and the National Health Authority;

- gather and process planning information;

- carry out planning and administrative routines for public transport companies and taxi services.

Overall, this means significant possibilities of achieving a more efficient utilization of resources and thus economic savings.

The BCI-Centre is what one might call "modally-indifferent" -- that is, it is based on the concept that what is important to the citizen is safe, efficient, convenient and reasonably priced transport, and that such things as vehicle size, color or labeling are simply not important. The common booking, management and information service at the heart of BCI extends to buses, taxis, and ridesharing arrangements, including E&H transport and car pools.

In a BCI system, the intending passenger calls into the Centre, at which time a check of all existing schedules (public transit), tours (paratransit), or vehicle location and occupancy patterns (taxis) is automatically carried out by the multimodal computer system. At that point, the caller is informed of his options and then "contracts" for the preferred service.

5.6. TaxiCom Market Size and the Pace of Innovation

Till now the development of TaxiCom in Europe has hinged above all on the determination of a handful of thoughtful and courageous taxi operators/collectives to try to harness two types of available technology (computers, digital radio) to deal with some of their main outstanding operations problems -- and until recently that of a single industrial group (Volvo) to develop a generally applicable package of equipment and services for the international market place. Gradually these pioneers are being joined by others, but until now the movement has not been looking at the mass market.

This is not likely to stay the case in the future. With a dozen installations now on line and proving the usefulness of the basic approach, we are fast approaching a situation in which the mass market can be expected to begin to open up.

The following figures provide an idea of the speed with which TaxiCom services are penetrating in actual operational contexts within Europe. The first reports on the total number of TaxiCom projects in commercial service as of the indicated year; the second, the number of vehicles participating in the various schemes implemented to that date.

Table 5-4: TAXICOM SYSTEMS IN COMMERCIAL SERVICE IN W. EUROPE

Year	Total # Systems	
1979	0	
1980	1	***
1981	1	***
1982	3	**********
1983	7	**********
1984	10	**********
1985	15	**********

Table 5-5: VEHICLES IN USE IN TAXICOM SITES

Year	Total # Vehicles	
1979	0	
1980	400	**
1981	400	**
1982	1225	******
1983	3401	**********
1984	5153	**********
1985	9863	**********

It is interesting to reflect on the implications of this trend for the future. There are today more than 200,000 taxis in Europe alone, not including the large number of in many ways similar vehicles such as those used for courier services, express delivery, pool vehicles, etc., all of which are equally susceptible to this sort of dispatching technology. Upon completing this survey, we are stuck by the fact that most of these vehicles are going to be equipped with this type of equipment over the coming decade.

How absurd is that notion? If one looks at the trend indicated in Figure 5-3, and bears in mind that the average taxi conversion market over the decade according to the above will run on the order of 20,000 cabs, annually, this idea of a substantial and continuing market begins to appear attractive.

As will be seen below, at several thousand dollars per vehicle for on-board equipment and a roughly similar amount for other supporting equipment and services, this suggests an annual market potential of close to $100 million over each year of the coming decade. In W. Europe alone! A market large enough, we would think, to spark some pretty vigorous competition and new product offerings.

Further if we assure:

a) That virtually every taxi will need something like this to remain viable in the future (and that is our assumption); and

b) That it will take somewhere around a decade to bring all of them on line, then .....

we are talking about an average market for the OECD region as a whole of some TWO HUNDRED MILLION DOLLARS A YEAR, for equipment and services for these conversions.

A market of these dimensions could drive some pretty interesting changes in technology, products and the kinds of services that could be offered.

6. PLANNING AND IMPLEMENTING YOUR TAXICOM

The reader may by now have decided whether it is going to be of interest to look further into this technology and service concept for eventual implementation in his community. And while the previous chapters have amply introduced the various approaches currently available in Europe in terms of their organization, technology, performance and costs, it will doubtless be helpful at this stage to know a bit more about the scale of time and resources that may ultimately be needed in order to plan and get such a system up and running. And to have some concrete leads as to where to turn for further information, guidance and perspective, both on TaxiCom in general and in terms of certain system offerings, possibilities, pitfalls, etc.

The following chapter is intended to deal with the first of these issues, while the annex that closes the report should help the reader understand where to turn next for further background and support.

6.1. Selecting the Right Planning/Implementation Path

6.1.1. Getting the Focus Right

We must open this chapter on planning by stating a prejudice. Namely, that after having carefully surveyed these systems and their results in the field we are struck by the fact that from the outset **equal weight should be given to using Taxicom as a means for obtaining not only what we can call dispatching improvements but also on trying to capt the full benefits of computerized fleet management!**

Most of the conversion programs undertaken to date have focused mainly on the dispatching aspects -- which we see as important but as only part of the opportunity. Certainly one advantage of such a more limited focus is that it presents the project team with a simpler and more limited target, much of which is basically technical in nature.

However, for Taxicom to have its full impact it will be necessary that the initial investigations and planning program be extended right into the bowels of the concerned organization to take advantage of this opportunity to create a fully integrated management and business planning system with entirely new kinds of potential for improvement and adjustment directly built into the new business structure.

Certainly such an approach may have the undesirable effect of slowing down a given project. However the potential benefits of such a more far-reaching approach should substantially outweigh any such short term inconvenience.

6.1.2. Going It Alone?

A TaxiCom system can be developed on the basis of a wide range of different operational and equipment configurations. Even within a given proprietary package such as any of those described in these pages, there is not just one way to build such a system. Within each established supplier package, there are a wide variety of service and equipment options available. The final details of the choice in any specific site will reflect the client's appreciation of his own unique requirements as far as such things as appropriate system size, complexity, speed, convenience, and reliability are concerned. And, of course, the available budget!

There are basically two ways to approach the challenge of planning and implementing a new TaxiCom system. Certainly, nothing keeps the community, taxi group, or other would-be implementor from setting out to develop its own original operations, hardware and software package. Most of the equipment needed can be purchased off the shelf from a considerable number of vendors. As far as software is concerned, there are a variety of packaged programs that can be purchased, tailored and combined in order to service a number of the operational functions. For the rest, it is "solely" a question of time, energy, skill and ... money!

Before setting out to work on a home brew TaxiCom, however, we would urge you first to consider carefully the scale of time and resources that others have needed when they set out to innovate in this particular manner. As will be noted from the information contained in the preceding pages, the challenge is not inconsiderable. Moreover, the potential costs of original innovation in this area can be quite high, as are the risks of failure.

Against this background, it is our suggestion that, whatever your intended development path, you first give your full attention to improving your knowledge of your actual requirements and priorities on the site -- and at the same time to developing in as much detail as possible full background concerning what is **already** available to deal with these needs. In this respect, we encourage you to take contact with all available supply sources and to listen to what they have to suggest by way of a solution, before taking any final decisions in this respect.

In this way, even if you eventually decide to go it alone, your data base and level of expertise should already have been greatly improved -- as should be your chances of success!

6.1.3. Modularity and Technical Up Grades

The best TaxiCom development projects have given considerable attention to the principles of modular system design. In those which have moved ahead we note two slightly different approaches in this respect.

Both the VTS and the Philips teams have designed their systems for phased implementation and upgrading -- on the basis of technology and equipment which is already (or which is at least claimed to be) fully available at the present time. Each proposes a "path" of increasing operational and equipment sophistication, with simpler alpha systems to be introduced at the outset and then gradually added to and expanded in discrete increments in order to arrive in due course to a full-featured systems package. Behind this approach are two implied notions:

a) That the needed technology, equipment and routines are already fully in hand; and

b) That these will be introduced once the necessary experience with (and public confidence in) the alpha system has been achieved.

At the other end of the spectrum, the Computer Cab project takes a more open-ended approach to upgrading and expansion as explained in Chapter IV above. What is different in their case is that their attitude is on of saying:"Well, we'll first deal with the problem of computerizing our basic dispatching function, then we'll catch our breath and go on to a more sophisticated accounting and billing package, and then ...".

In view of the results being obtained, there is probably reason to look at both approaches before deciding which will best suit your particular situation.

6.2. Upgrading from Conventional Dispatching

TaxiCom is an approach which can either be useful for communities which are presently without existing radio taxi operations -- or, alternatively, as an "organizing overlay and superstructure" in cases where conventional radio dispatching technologies and, even, computer support of various types might already be in place.

For such cases as the latter, we see TaxiCom as providing, among other things, a golden opportunity to re-think the entire system's orientation, organization and facilities use. In fact, it is worth noting that in virtually all of the communities where such installations have been set up:

(a) they already had full-fledged and, by the usual industry standards, highly adequate radio dispatching services, and

(b) virtually all were **already** using computers for a variety of support purposes.

This is a message which we feel is worth bearing in mind: That is, that the places most likely to turn to TaxiCom (and to benefit most from it) are those communities and taxi operations that have already taken some steps in this direction. Thus, TaxiCom will give them, as much as anything else, not a magic wand to transform their otherwise failing or moribund operations, but rather a structured program along which to channel yet further operational and technological improvements.

6.3. Main Planning and Implementation Steps

It will take time and resources to get even the simplest TaxiCom up and running. Now with more than a dozen projects in service (or close to it), it is beginning to be possible to get a fairly accurate fix on the scale of time and resources -- and skill -- that are going to be required for your project.

Planning and preparation for the first Taxi-80 project (in Gothenburg) stretched over six full years from 1976 to 1982... understandably given the fact that this was the first experience of its kind. Similarly it required close to four years to get the Zurich Telco project fully on line, and three full years for the London Computer Cab. AP-Radio has been working directly with the Oslo Taxi central since 1980 and that system is still to find its full stride.

Against this background of accumulated experience, however, -- not to mention the equipment, software and routines that have now been mastered over all this time -- planners of future projects can now reasonably expect to be able proceed more quickly, and perhaps even much more quickly!

Specifically, we estimate that somewhere between twelve and eighteen months should be budgeted in order to plan and organize a full scale TaxiCom system in a city of a million or less, once those primarily concerned have agreed on its basic advisability. If there are pockets of resistance, considerably more time may be required. Obviously, too, the larger and more ambitious the system, the longer and more arduous will be the planning and implementation process.

We see the work of planning and implementation as proceeding in seven or so broad phases, roughly along the following lines. Cited budget and time figures are generally "soft" and meant to suggest orders of magnitude that we believe to be appropriate. There will be considerable variation, of course, depending on the size of the project, its complexity, etc.

More than one organization exists that is ready and qualified to take your particular operation all of the way through this study, planning and operations cycle. As has been seen, VTS and AP Radio are already handling such projects on a regular commercial basis in Europe. Several North American firms (cited in Annex A) are also presently offering such capacities.

In the event, it seem appropriate that at whatever stage you decide to bring in your definitive systems consultant, the further you have managed to get the query along on your own first, the better. Certainly, there is every reason to be sure that you yourselves carry out the Initial Study and possibly even the Pre-Feasibility Probe, prior to making a final selection of contractor.

6.3.1. Initial Study Stage (In-House Project)

Decision Objective: Should we look further into TaxiCom for eventual implementation in our community/company?

Tasks: Carry out rapid informal survey to determine if TaxiCom is potentially appropriate in target situation. What has already been done along these general lines (radio dispatching, computerization, joint equipment purchase, collaboration billing arrangements, etc.) and how has it fared to date? Initiate informal contacts with main concerned groups and agencies to gauge their position, eventual reactions, etc. Contact all known vendors, supply sources, consultants and ask them for a "document dump".

Representative Resource Requirements: Should be able to be executed on part-time basis by lead agency, over a period of no more than one or two months. No formal budget.

Final Product: Internal memo on key points as per above, plus supporting documentation and full contact information for eventual follow-up.

6.3.2. Pre-Feasibility Probe

Decision Objective: Determine once and for all if TaxiCom is going to be potentially useful/broadly acceptable for community. Verify that appropriate institutional support exists.

Run "Environmental Check List": physical definition of likely service area; absence or presence of topological difficulties; verify adequate radio channel availability. Develop initial menus of system objectives, service requirements, specific targets of each key sub-group concerned (taxi operators, drivers, users [including elderly and handicapped people, children, etc.], public transport agencies, local government, etc.). Preliminary costing, decision basis and funding for full scale feasibility study. Sketch plan(s) for finance. Prepare short list of firms to run feasibility study.

Representative Resource Requirements: Skilled (independent) consultant, with full local sponsorship and support. Several man-weeks -- possibly up to three man-months. Budget: ca. $5-15,000 (probably more in very large cities).

Final product: 30-50 page report with recommendations on all key points, plus final debriefing session which brings together all key groups and agencies.

6.3.3. Feasibility Study

Decision Objective: Definitive guidelines for all main actions/decisions that need to be made concerning project over remainder vof planning as well as full implementation/running-in cycle.

Tasks: Ensure full contractual participation of all key parties. Set up Steering Committee. Scope in detail all activities/output requirements. Organizational plan. Full environmental clearance/plan. Regulatory aspects. Detailed program budgeting. Complete financial plan. Operations plan outline. Identify alternative suppliers/technology sources. Specification of all hardware/software. Phased implementation plan. Secure financing. Ranking and justification of preferred supply sources. Prepare all contracts.

Representative Resource Requirements: Anywhere from 2 to 6 months. Small multi-disciplinary team with eventual local project manager, preferably already on board. Budget: $10-30,000

Final product: Detailed Feasibility Report, with phased Implementation and Financial Plans.

The next four stages can at this point simply be mentioned for the record. The full details will need to be sorted out on a case by case basis and, in the event, will be substantially clarified by the preceding.

6.3.4. Full Operations Plan

6.3.5. Equipment Purchase and Installation. Training.

6.3.6. Testing, Debugging and Trial operation

6.3.7. Operations, Monitoring -- and (later) Extension

==========

In actual fact there will, of course, be numerous overlaps between these various stages, and in some cases room for compression. Thus, in a smaller community where the necessary institutional consensus may be reached immediately and the local taxi operation has already made some progress in its earlier modernization and improvement efforts, the Pre-Feasibility Probe, properly handled, can begin to extend into Step 3 with no problem. It will be in the latter phases, however, where the main overlaps will inevitably occur.

As far as the reader of this report is concerned, it is likely that the first two of the above steps will be of most immediate concern at this point.

In general, there is much to be said about making sure that the key yes/no issues are bought out and resolved one way or another as early as possible in this process. By way of reminder, we can note that these are:

- Is there a felt need for this type of service in the community? (Operators? Drivers? Users? Local government? Others?)
- Does appropriate support appear to exist in all the right places?
- Is there the appropriate radio space as needed to support system?
- Are there are no other major environmental barriers?
- Ditto for legal, other barriers?
- Can the project be phased in a way to permit self-financing?

6.4. Initial Study Notes and Guidelines

The basic objective at the outset will be to determine: (a) if there is a potential match between what TaxiCom has to offer and your city's particular size, shape and structure. No less important is (b) to try to make sure that there is going to be the right sort of institutional support for what in the final analysis is to be a broad-based collaborative effective.

Here are some of the issues that need to be probed and nailed down as quickly as possible:

6.4.1. Institutional Inventory and Attitudes Survey

This inventory will aim to identify the who, what and how of the local taxi scene in your community, with care to ascertaining the attitudes, needs, etc., of each of these groups:

- Taxi ownership structure and composition
- Drivers/Groups
- Dispatching/Control center
- Regulatory situation and leading agencies
- Local government agencies
- Public transport and other carriers
  (Including paratransit, Easter Seal and other E&H handicapped transport, school transport, major car and van pools)
- Labor union considerations
- Public interest/ user groups

6.4.2. Inventory of Taxi/Paratransit/Transit Sector

This inventory is intended to identify the status of all key inputs to sector.

- Vehicle Inventory (number, ownership, type, age, cost, financing)
- Mobile equipment inventory - radios, fare meters, other
  (number, ownership, type, age, cost, financing)
- Dispatching center/ administrative support inventory
- Radio base stations, relay facilities
- Work force inventory (numbers, sex, full/part time, compensation, levels, income)
- Financial capacity
- Shared facilities and other forms of collaboration

6.4.3. Radio Taxi Facilities Survey

- Ownership
- Capital and operating cost summary
- No. participating taxis
- Exact services currently rendered
- Cost of subscriptions:
    - Forms
    - Equipment ownership
- Employees
- Type and background
- Working Hours
- Wages
- Contractual agreement (full time, part time, labor union)
- Switchboard (type, cost, condition)
- No. telephone lines
- No. and frequency of radio channels
- Total calls/orders handled
- Breakdowns: by type and time distribution
- Average access time (Min., Max.)
    - Incoming callers
    - No. calls required to get through
- Processing time (Mean/Min., Max.)
    - To take order
    - To contact and verify taxi
    - To inform caller
- No. show/lateness indicators
- Error indicators
    - wrong address
    - incorrect taxi
    - other

6.4.4. Current Performance Survey

- Fare system and levels
- Number of rides/passengers/per day
- Hourly, monthly, other distribution of riders and income
- Taxi access by type (radio, hail, stop, contract, other)
- No. taxi stops (and location)
- No. and type of pass./veh./hr.
- Revenue miles/total miles
- Rev./mile
- Rev./taxi/day
- Ave. Wait Time
- Contract Revenue/Total Revenue
- Monthly expenses
- Gas Mileage
- Veh. Mileage
- Ave. veh. life
- Ave. insurance/taxi
- Profits
- Other ?

6.4.5. General Transport Indicators

For each other transport mode in the area, we shall need to know: fleet size, performance, availability, costs,...

- Public transport
- Private cars
- Paratransit
- Two wheel/other
- Unfulfilled transport demand

6.4.6. Socio-Economic Indicators

This survey should cover both the entire area of community or agglomeration, as well as providing details on those particular neighborhoods or areas where service might initially be offered or later expanded to indicate.

- Population
- Land area
- Basic travel patterns
- Main activity nodes
- Telephone availability
    - residential
    - work
    - public or other
- Income levels
- % Transport disadvantage
- other

6.4.7. Methodological Comment

Of all of the above, there is no doubt that the hardest to nail down is going to be specifics on current taxi performance. Nonetheless, it is important that the planning team get as far into this data as possible -- if not on a conclusive total fleet basis, at least with the help of some cleverly conceived mini surveys.

For the purposes of these surveys and the other necessary study activities at this stage, the skilled investigator is going to be able to make good use of the (usually abundant) materials that already exist in many places in both this and closely related areas: e.g., transport studies, economic development studies of the area, city plans, etc.

We also suggest that the considering organizations make contact as early as possible with the competent supplier groups who have already established a track record in this field, to seek their suggestions and guidance as to what to look out for in this critical preliminary study phase (See Annex A below for full details here). If these individuals/groups are approached properly, it should be possible to seek out their general suggestions for pre-screening, without necessarily locking oneself into a possible premature contractual relationship.

For the rest, well placed interviews and a number of group meetings should suffice.

6.5. Two Key Institutional Measures to Ensure

6.5.1. Steering Committee

One wise advance precaution should be to set up a Project Steering Committee at the earliest stage possible, in order to provide a forum for all those persons and groups most immediately concerned. One of the first tasks before the project's organizers would then be to ensure, first, the broadest possible coverage of those concerned and, hopefully as a result, the eventual inputs and support of the various groups thus brought together.

Typically, the following interests should be represented on the Project Steering Committee:

Table 6-1: COMPOSITION OF TAXICOM STEERING COMMITTEE

- All fleet owners
- Leading owner/operator representatives
- Public transport operators
- Paratransit operators (if any)
    - DRT
    - "Easter Seal" or other special community services
    - Transport brokerage unit (if any)
    - other
- Taxi dispatching operations (if any)
- Local government officials
    - mayor's office
    - police department
    - regulatory agency
- Labor union representatives (if appropriate)
- User groups
- Other (including appropriate state or national agencies, if involved in finance or other crucial aspects)

The organization and concertation of a group with such a wide range of interests and styles will not be easy. However, unless this is done, and their full and active support is acquired early, there is no way that the project can expect to go forward.

In point of fact, it may prove useful to develop a slimmed down Sub-Committee which will be charged to handle the more time consuming aspects of consideration, negotiation, etc., and torn to the full Committee in plenary session only occasionally where a full and formal consensus is needed.

6.5.2. The Media

Careful orchestration of the media can be most helpful to ensure TaxiCom success. Among the public information tasks that need attention from the outset:

- Ensuring broad-based public support of project

- Informing public about TaxiCom use (both for original service and, in time, for add-ons as they occur).

- Ensuring that public expectations are realistic.

As past experience shows, the main media dangers are the Scylla of no or negative coverage, and the Charybdis of starry-eyed articles which create unrealistic expectations which can turn into time bombs once the TaxiCom begins to enter service in its (hopefully modest) alpha mode.

6.6. Potential for Phased Implementation/TaxiCom Extensions

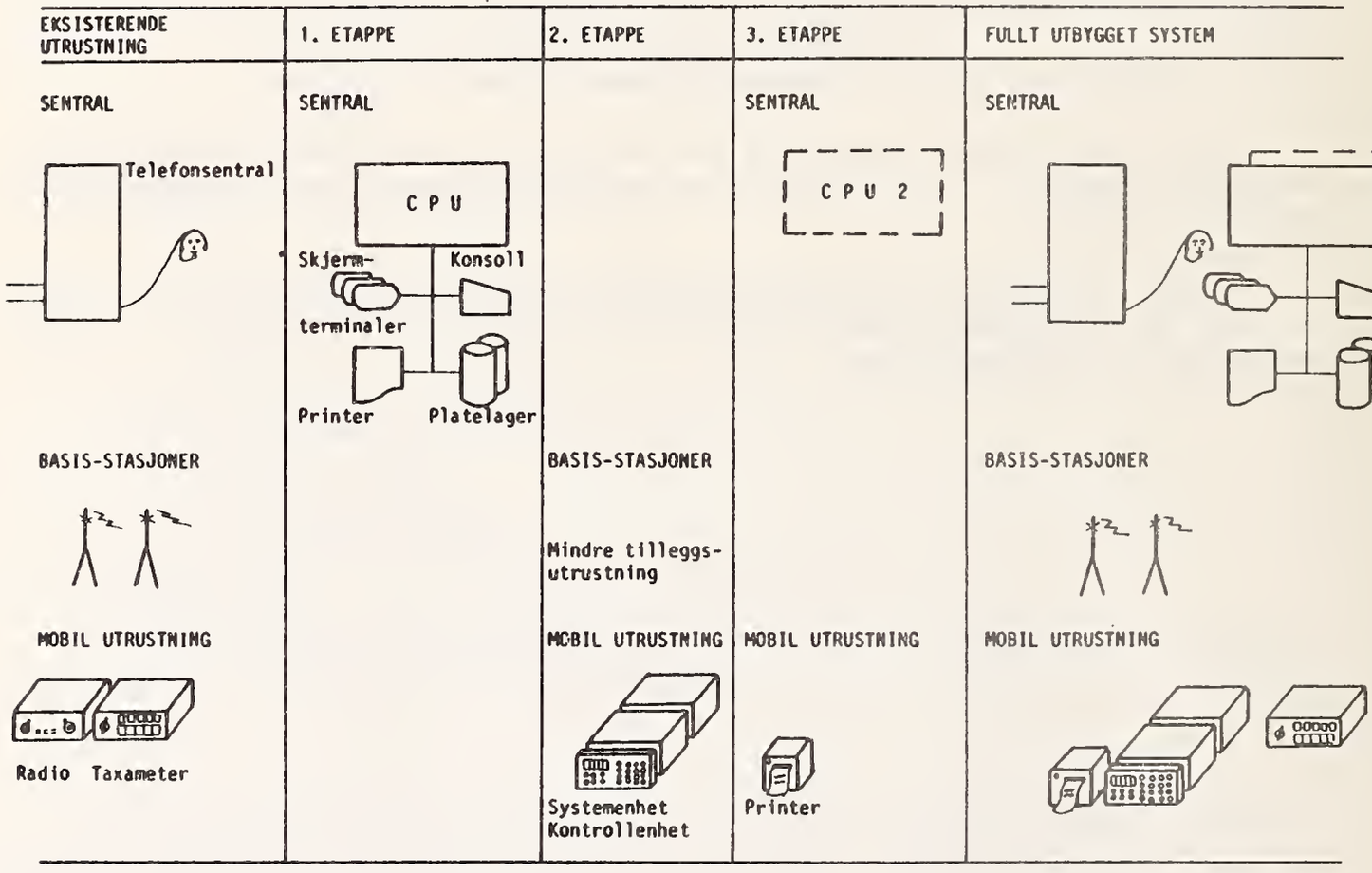
Once the overall objectives and means of TaxiCom have been identified for your community, it is going to be possible to plan and bring the system on line in stages.

A good example of one kind of phasing taken for projects of this sort is the plan originally developed by VTS in 1981 for the Trondheim system and which is reported below.

6.6.1. Hardware Aspects

The following figure shows how the organizers structured an implementation program whereby their existing radio dispatching system could be upgraded into a full scale Taxicom system in clear and affordable phases -- each of which brings its own improvements.

Figure 6-1: PHASED HARDWARE IMPLEMENTATION PROGRAM
(Trondheim Taxi-80)



Source: VTS

A properly phased program should be spread out over months or years in order to ensure that: (a) each major new component can be fully tested and integrated into commercial operation prior to taking on the next set of problems; with (b) certain immediate improvements already obtained as a result of the technical advantages of the next equipment and routines.

6.6.2. Software and Service Extensions

It will be similarly possible to extend and upgrade the global system in phases, bringing in new software and routines once adequate experience has been accumulated at the previous level.

The following chart shows how this was pre-planned for Trondheim.

Table 6-2: PHASED SOFTWARE IMPLEMENTATION PROGRAM
(Trondheim Taxi-80)

Stage I: ADVANCE RESERVATION COMPONENT

- Advance reservation service
- Statistics - I

Stage II: DIRECT ORDER COMPONENT

- Direct orders
- Vehicle location and status monitoring
- Emergency alarm routine
- Expanded statistics function
- "Soon free" function (limited trial program)

Stage III: "RECOMMENDATION FUNCTION" COMPONENT

- "Soon free" function (full program)
- Fleet planning
- Text communications
- Planning

Further extension beyond the above is also to be anticipated.

7. POSTSCRIPT: PROSPECTS FOR THE UNITED STATES

The survey suggests that TaxiCom is now ready to be profitably adapted and employed in communities across the United States on the following grounds:

(1) It is appropriate for service areas ranging from small towns or suburbs to large metropolitan areas.

(2) It can be brought on line without a need for public sector involvement or subsidies and making use of the dynamic entrepreneurial and management capacities of the private sector.

(3) It holds out a wide range of opportunities both for the transport disadvantaged and for the traditional taxi user.

(4) It can serve as a cost-effective supplement to deficitory public transport services in lower density areas and in off-hour periods of low demand, as well as a "starter service" for new communities where travel density has not built up to the point of justifying dedicated transit service.

(5) It could not only serve as a significant transport improvement, but could also come to the aid of an important but in many ways troubled sector -- the taxi business.

EcoPlan believes that with good organization and management TaxiCom can prosper in most urban and suburban settings in the United States.

ANNEX

A. KEY CONTACTS AND INFORMATION SOURCES

The following is intended to facilitate contacts by interested public authorities and operators in their search for more background on these systems and their prospects. Neither EcoPlan nor UMTA vouch for or recommend any of the following:

A.1. Key Sources

A.1.1. TaxiCom Project Managers - Europe

The following identifies those taxi firms with direct hands-on experience with these approaches and technologies. They will obviously be among the best possible sources of information and perspective on the systems introduced in the study.

A.1.1.1. Sweden

Gothenburg Taxi Economical Organization
Eklandagatan 55
41264 Gothenburg

Mr. J. Lootsman
Project Manager
Tel: (46/31) 81.31.10

Mr. Karl Erik Hultgren
Project Director
Tel: (46/31) 17.03.40

Malmo Taxi Economic Organization
Zenithgatan 66
S-212 14 Malmo

Ms. Migken Wendal
Project Manager
Tel: (46/40) 120-244

Mr. Paul Klimfors
Chairman
Tel: (46/40) 120-244, 183-103

Taxi Trafiforening upa
Municipal Taxi Organization
Radmansgatan 48
S-113 57 Stockholm

Mr. Ralph Swahlstedt
Project Manager
Tel: (46/8) 976-790

Mr. Laismark Bertil
Chief Computer Operator
Tel: (46/8) 314-862

Boras Taxi
Box 10059
50010 Boras
Mr. Fritz Peterson
Project Manager
Tel: (46/33) 127-070

Linkoping Taxi Economic Union
Longgatan 73
58267 Linkoping
Mr. Anders Ahlinder
Product Manager
Tel: (46/13) 121-752

A.1.1.2. United Kingdom

Computer Cab Co. Ltd.
7 Woodfield Road
London W92BA

Mr. Steve Tubby
Project Manager - Technical Director
Tel: (44/1) 286-2728

Mr. Geoff Kaley
Managing Director
Tel: (44/1) 286-2728

A.1.1.3. Switzerland

Taxi Zentrale Zurich AG
Pfingstweidstrasse 31 A
CH-8031 Zurich
Mr. Edwin Biefer, Dipl. Ing. ETH
Project Manager

Mr. W. H. Fuchs
Managing Director
Telco
Pfimgstweid Str. 131 A
8000 Zurich
Tel: (41/1) 444-441 or 442-420

A.1.1.4. Netherlands

Rotterdam

Taxi Telefonzentrale
Westzeedeijk 98
3016 AG Rotterdam
Mr. Van Hoorn
Director
Tel: (31/10) 362-620, 360-600

A.1.1.5. Norway

Baerum Taxi Central
Ramsletta 2
1322 Hoevek
Mr. Herloffon
Managing Director
Tel: (47/5) 539-445

Taxi Central Bergen (Headquartered in Oslo)
Hoesaret 11
Oslo 2
Mr. Jan Terje Rogneby, Project Manager - Taxi-80 Norway
Tel: (47/2) 554-890

Taxisentrale Bergen
Tel: (47/5) 322-222

Oslo Taxi Central
Trondheimsveien 100
N Oslo 5
Mr. Ole Soelberg
Manager of Operations
Tel: (47/2) 388-000

Mr. Francke Sonstebo
Chief - Oslo Taxi Owners Association
Tel: (47/2) 388-000

Taxisentrale Trondheim
Princegate # 32
7000 Trondheim
Mr. Einar Bjorgen, Manager
Tel: (47/7) 524-568, 527-600

Stavanger Taxi Sentrale
Tendergaten 99
4000 Stavanger
Mr. Ole Uenand, General Manager
Tel: (47/45) 532-453, 260-40

A.1.2. System Suppliers - Europe

The following companies are actively bidding on TaxiCom variants, and all have direct hands-on experience at the operations level as well.

Computer Cab - UK
See Computer Cab listing under Operators (above)

AP Radiotelefon A/S
Jenagade 22
Copenhagen S
Mr. Moerk
General Manager
Tel: (45/15) 477-777
Telex: 31172 APTELE DK

Mr. Benoch Nielsen
Project Manager

TELCO Telefon-Computer AG
Pfingstweidstrasse 31 A
CH-8031 Zurich
Switzerland

Mr. Edwin Biefer, Dipl. Ing.
Project Manager
Tel.: (41/1) 44 24 20
Telex: 823 369 TZAG CH

Mr. W.H. Fuchs
Commercial Manager

Taxi Telefooncentrale "T.T.C." N.V.
See Taxi Telefooncentrale listing under Operators (above) and Breur Consultancy Group under Consultants (below)

VTS-Transportation Systems Corp.
S-405 08 Gothenburg
Sweden

Mr. Hakan Arnbert
Tel: (46/31) 50.79.92

Mr. Claes Westberg, Vice President

A.1.3. Consultants and Software Suppliers - Europe

Additional materials and perspective can be developed through the following sources.

Breur Consultancy Group
Laankcopas van Kattanburch
2585 - EV The Hague
Netherlands

Dip. Ing. Anthony Breur
Tel: (31/70) 608.355

Mr. Wim Faber
Transport Consultant
Clayslaan 82
1030 Brussels
Belgium
Tel: (32/2) 736-4887

Multiplications
1050 Massachusetts Avenue
Cambridge, Ma. 02138
United States

Mr. Daniel Fleishman
Senior Transportation Analyst
Tel: (1/617) 864 5810

SNV
Lokstedter Weg 24
D-2000 Hamburg 1
F.R.G.

Mr. Zacharias
Project Manager

SNV
Auguste-Viktoria-Strasse 62
1000 Berlin 33
F.R.G.

Dr. Ing. V. Sparmann
Managing Director
Tel.: (30) 820 07 0

A.1.3.1. Related North America Suppliers

The following list identifies those North American firms who are known to work in closely related areas and who could also be usefully contacted in conjunction for additional information, opinion and eventual offers. Three in particular are known to be currently offering a TaxiCom-like system: Gandalf, Mobile Data International, and Ramos Systems Incorporated. Gandalf has secured contracts for its Taxi Dispatch System in Anaheim, California (65 vehicles); Indianapolis, Indiana (250 vehicles); and most recently New York City, while MDI has three installations in Canada. both are looking at European markets as well.

Gandalf Data Ldt.
100 Colonnade
Nepean, Ontario
K2G0B7
Canada

Mr. C.D. Patterson
President
Tel: (613) 226-6500
Telex: 0534728

or

Gandalf Technologies, Inc.
9 Slack Road
Nepean, Ontario
K2E7N4
Canada

Russell Hicks
Marketing Manager
Tel: (613) 225-0565

ICC Information Systems
2657 West 87th
Evergreen Park, Il. 60642
United States

Russ Chobot
Tel: (312) 870-7927

Mobile Data International, Inc.
210, 10991 Shellbridge Way
Richmond, B.C.
V6X3C6
Canada

Mr. B. Isherwood
President
Tel: (604) 278-2556
Telex: 04355865

Mr. Jeff Morris
Sales Manager

Ramos Systems (Taxi CAD)
1725 Timberway
Richardson, Texas 75081
United States

Jerry Moore
Tel: (214) 690-4377

Transmax, Inc.
2121 West Crescent Ave., #F
Anaheim, Ca. 92801
United States

Basil E. Potter
Tel: (714) 524-2733

A.1.4. Public Sector Institutions/Associations

The following public sector institutions and agencies can be useful sources of further information and perspective on these systems.

International Taxi Association
11300 Rockville Pike
Rockville, Maryland 20852
Mr. Alfred B. LaGasse, III, Executive Vice President
Tel: (301) 881-1333

National Federation of Taxicab Ass. (NFTA)
104/106 Percy Street
P.O. Box Newcastle-Upon-Tyne NE99 2BL
Great Britain
Mr. J.R. Oswell
National General Secretary

Corporation for Urban Mobility
One Farragut Square, Suite 200
Washington, D.C. 20006
Mr. C. Kenneth Orski, President
Tel: (1/202) 737-7331

Dept. of Transport - S. Australia
State Administration Centre Victoria Square
P.O. Box 1599 Adelaide, Australia
Dr. Derek Scrafton, Director General
Tel: (61/8) 228 4143,82827

Office of Bus and Paratransit Technology
Department of Transportation
UMTA - URT - 41
Nessif Building, Room 6107
400 Seventh St., S.W.
Washington D.C. 20590
Mr. Edward Neighut, Program Director
Tel: (202) 426-9271

Institute of Transport Economy
P.O. Box 6110
Grunsevn 86
Oslo 6
Norway
Mr. Dag Bjornland
Tel: (02) 19 49 00

PRO - Licensed Taxi Drivers Association
9/11 Woodfield Road
London W9 2BA
England
Mr. David Barnes
Tel: (44/1) 286-1046

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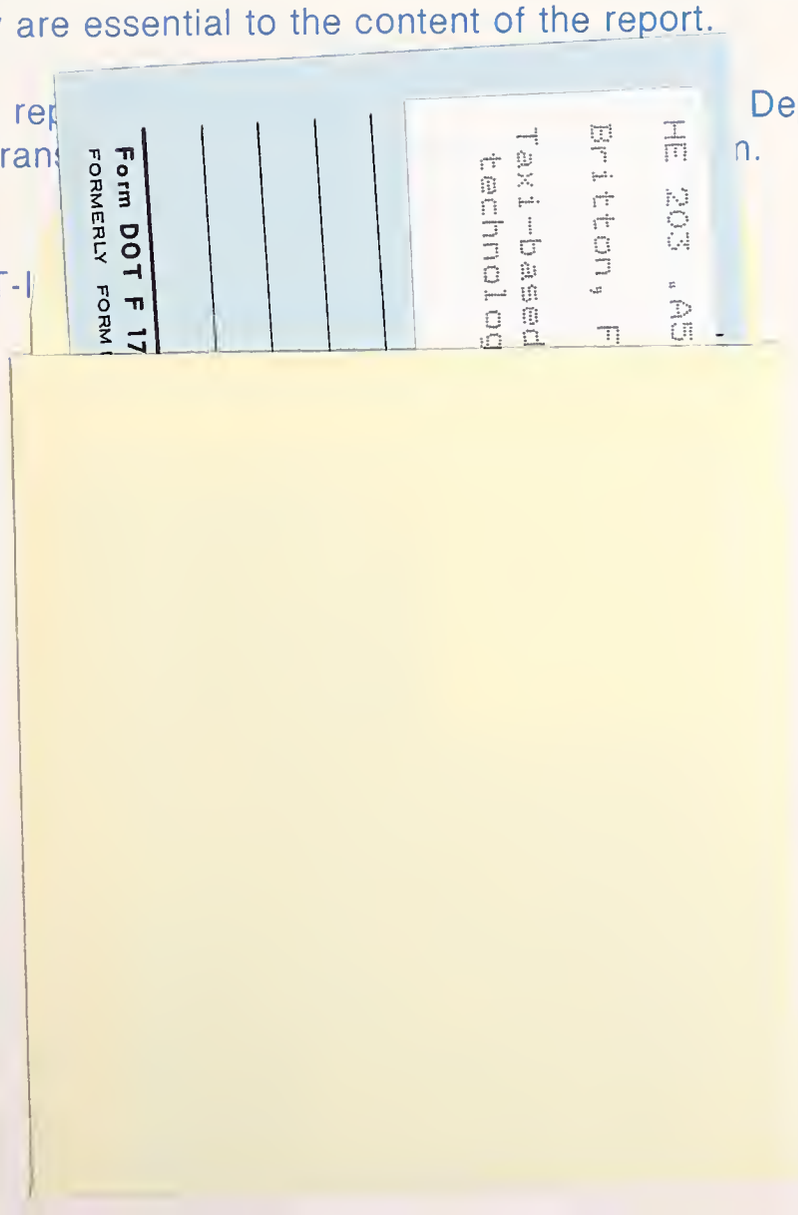

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